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IN SCIENCE

newscientist

Food additives
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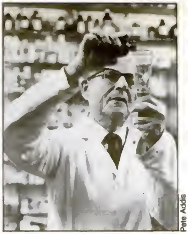
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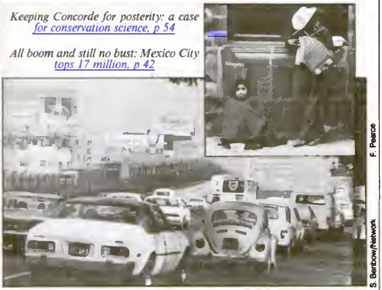
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Ian McKinnell

NEXT WEEK

Can we fuel the diesel?
Unless fuel producers and motor manufacturers can agree, the price of diesel will soar

Badgers: the slaughter of the innocents

Soviet spacewalkers

Marine worms signpost pollution

Black medicine

SOME OF Britain's leading medical scientists are packing their bags for a visit to a medical school in South Africa. They will see whether the standard of medicine taught there is as good as that in Britain. The four professors are from the General Medical Council, the statutory body that oversees medical education and medical ethics in this country. Should these eminent gentlemen decide that the Medunsa medical school matches those in Britain, then this country will recognise the degree of graduates from that school and its graduates will be able to practise medicine here.

However, the South African government ultimately decides whether a doctor from this medical school can practise abroad. Without exception, graduates from the school will have one thing in common, they will be black. The Medunsa medical school is for black students only. They will be taught by black teachers, and they will have the opportunity to treat only black people.

The GMC is now in the unfortunate position of judging a medical school that is part of the apartheid system of South Africa. The position is invidious. If the GMC refuses to go to South Africa then how can it justify boycotting the first black medical school when it has already sanctioned the country's white medical schools? And yet, if it goes it will undoubtedly incur the wrath of those who see it as yet another propaganda triumph for the racist regime.

Already, in the *British Medical Journal*, there has been irate correspondence aimed at the GMC, whose chairman, Sir John Walton, is having to fend off accusations not that he is supporting apartheid but that he will be *seen* to be supporting apartheid.

It is difficult to see a way out for the GMC. Its problem lies with its long historical links with South African medicine, during which it has recognised the degrees of graduates trained in all-white medical schools. From the time it began travelling down this path, it has become increasingly difficult for the GMC to change course. And now it has led to the GMC possibly approving South Africa's first black medical school.

The Overseas Doctor's Association, a body that represents 20 000 foreign doctors who work in this country, is not happy with the visit. Its chairman, Dr Karim Admani, argues that the medicine taught at the Medunsa medical school will be very different than elsewhere in South Africa. The resources will not be the same, the diseases of the patients will not be representative of the population in general (essentially because black victims of less serious ailments are not encouraged to go to hospital) and so the medical graduates will, inevitably, end up being trained in a peculiar "black" form of medicine.

In short, how does the GMC justify a visit to a country where one of its medical schools is at a disadvantage because it is part of a medical system that segregates medical students in terms of skin colour?

The GMC describes itself as a non-political body in the hope that it can wash its hands of the apartheid principles on which South Africa stands. But it is naive to believe that a non-political body can visit and judge an all-black medical school that exists because of a political system.

At the end of last month, the General Assembly of the United Nations voted overwhelmingly to reject South Africa's new constitution, giving "coloureds" the vote while ignoring the vast majority of the population, which is black. In that vote, there were 133 countries in favour of the motion, and none against. There were two abstentions, the US and Britain. Unlike the British government, the GMC should not abstain from its obligation to see that medicine is taught and practised without prejudice. This is not the case in South Africa. □

Nobel pursuit

IT IS GOOD to see scientists from Britain retaining their place in the Nobel race. But the euphoria obscures too many issues.

First, why did it take so long for Cesar Milstein to take home the goods? We gave up predicting who would win Nobel prizes years ago. Not because it is impossible to judge the quality of research, but because it is impossible to figure out the vagaries of the committees that, in their selection, play it so safe that by the time they come to award a prize, there are too many deserving candidates to make forecasting anything more than a game of chance.

Next we have to ask why the English-speaking and "Western" nations monopolise the prizes. Could it be because they also monopolise the selectors? Or perhaps the choice of subjects deemed to be suitable for preferment limits the field?

Before patting ourselves on the back too hard, we should also consider the way in which Britain treats its prizewinners *before* they receive this ultimate accolade. Far too often Nobel prizes have gone to British scientists whose work has been exploited by companies in other countries.

Cesar Milstein's admirable research led the way for the business of genetic engineering. Once again, we can see the commercial exploitation of this work being pursued more vigorously outside Britain. We may dismiss the excessive commercialisation of science in the United States and elsewhere; but that is no excuse for being so timid in innovation, as typified by the failure to patent Milstein's work, that we end up buying the products of our own inventiveness.

One thing that is clear is that while British scientists may do well in collecting Nobel prizes for science, they would do extremely badly were the Nobel Foundation to award prizes for innovation. And, what is worse, British companies wouldn't be in the running. □

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THIS WEEK

Nobel prize for inventors of monoclonals

THE NOBEL PRIZE

Omar Sattaur, Jeremy Cherfas and Debora MacKenzie, Geneva

AFTER years on everybody's shortlist, the men who invented monoclonal antibodies and set off a new medical industry have won their Nobel prize. The winners of this year's prize for medicine are Cesar Milstein, an Argentinian from Britain's Laboratory of Molecular Biology, Niels Jerne, a Dane born in Britain and based at the Institute of Immunology in Basle, and their go-between, the West German, Georges Köhler.

"Some of the nicest things about the project have been the surprises. As you go along you find things that aren't exactly what you want . . . but interesting nonetheless." The "project" Cesar Milstein was referring to was aimed at answering the question: How does the human body manage to produce tailor-made proteins that can fight any foreign matter you care to throw at it?

The search for the answer led Milstein and Georges Köhler to develop methods of making antibodies that have identical chemical structures and therefore identical functions. They called them monoclonal antibodies. For finding a way of making these highly specific antibodies Milstein and Köhler won the Nobel prize on Monday. They share the prize with Niels Jerne, whose theories on antibody diversity marked a turning point for the science of immunology.

Köhler made the first monoclonal antibody in 1975. He was at that time working with Milstein, then a senior scientist in the division of protein and nucleic acid chemistry at the Medical Research Council's Laboratory of Molecular Biology in Cambridge. They were fortunate to have as head of their division Frederick Sanger, the first scientist to receive two Nobel prizes for chemistry. He said of Milstein's accolade: "It's great news. He is a delightful person, very enthusiastic and extremely bright. He has a fantastic knowledge and memory. I'm sure I've learnt more from him than he's learnt from me." Milstein took over as head of the division when Sanger retired in October last year.

AP

AP

Dr R. Stepney/SPL

Köhler (top) and Milstein (right) invented monoclonal antibodies. But Jerne (above) provided the theoretical base. He had his inspiration as long ago as 1955

"The exquisite sensitivity of the immune system" is a phrase that crops up time and again in accounts of the body's defence system. The immune system is able to detect and take specific action against an enormously wide range of potentially harmful substances.

These substances, usually protein molecules on the surface of pathogens such as parasites, bacteria and viruses, are called antigens. Part of the immune system, the lymphocytes of the spleen and thymus, responds by making other proteins, called antibodies, which fit the antigens as a key fits a lock. Antibodies destroy the cells bearing the antigen, and they signal other cells to come to their aid.

So antibodies are extremely useful, primarily to combat disease, but in all sorts of other spheres of biomedicine too. The problem is that the very profligacy of the immune system, churning out antibodies to all manner of antigens, means that pure antibodies are difficult to obtain.

A single foreign protein may have several antigenic sites, and a single pathogen may carry many different surface proteins. The body responds with a cocktail of mixed antibodies; purifying out a single useful species of antibody brings the researcher up against the limits of physicochemical methods.

Enter monoclonal antibodies. These are made by a culture of genetically identical cells, a clone. Because a single lymphocyte manufactures a single antibody, a monoclonal culture secretes a pure product. But normal cells have a very limited life, managing only seven or eight cell divisions before they die. A culture derived from a lymphocyte, even though it would secrete pure antibody, would be too short-lived to be useful.

Cancer cells, by contrast, are immortal. A cancerous spleen cell would be an ideal antibody factory, but it would be impossible to predict which antibody it would secrete. To overcome the vagaries of nature, Milstein and Köhler set out 10 years ago to make their own lymphocyte tumours.

Köhler injected a mouse with a known potent antigen, red blood cells from a sheep. He harvested lymphocytes from the mouse's spleen, and mixed them with cells cultured from a bone-marrow tumour, encouraging the two cells to fuse. Köhler succeeded in creating an immortal cell line that secreted a pure antibody. These cells are called hybridomas.

Milstein and Köhler followed up on the original hybridomas by making monoclonal antibodies to other antigens. They soon realised the implications of their discovery. Monoclonal antibodies could be used to make the purest interferon. They can tell one cell type from another; one type of leukaemia from another. And the best thing about them is their reliability. They will exhibit the same properties every time, because each cell in the clone is identical. This is what Milstein meant ►

OBSERVER David Austin

NOW WE NEED A BLACK, A HISPANIC AND A GAY TO SPACE-WALK BEFORE THE ELECTION
WOMAN SPACE-WALKS

▸ when he spoke of the "interesting surprises" of his project.

The British government declined to patent the discovery, so Milstein and Köhler submitted a brief letter to *Nature* on 14 May 1975. It was published on 7 August, and its conclusion foresaw the immense interest and activity their discovery would generate: "Such cells can be grown *in vitro* in massive cultures to provide specific antibody. Such cultures could be valuable for medical and industrial use."

Milstein, who is 57 years old, graduated in chemistry from the University of Buenos Aires in Argentina in 1957. In 1958 he studied for his doctorate in the department of biochemistry at Cambridge University, then run by Professor Malcolm Dixon. Milstein first worked for the Medical Research Council in 1960, and returned to Argentina in 1961. For two years he headed the National Institute for Microbiology in Buenos Aires but he resigned and came back to England when four of his staff were sacked for belonging to a trade union.

Köhler, who is 38 years old, forms the personal link between the three prizewinners. He is expected to take over direction of the new Max Planck Institute for Immunology in Freiburg, West Germany, later this year. But apart from his two years with Milstein he has done all his work at the Basle Institute of Immunology (BII), which was started by Jerne.

Köhler said: "I think I was for my whole career very fortunate to be in a place like the BII, with its freedom from the worries of grants and tenure—all appointments are permanent. I was lucky from the beginning."

Jerne too was celebrating at the BII on Monday afternoon. Was he surprised? Somewhat, he told *New Scientist.* "When you do pure theory you don't really expect these things, since it's harder to judge than inventions." Still, he acknowledged that his theories "have been fruitful in some cases". A somewhat modest assessment of the theory he proposed in 1955 which was to give immunology a completely new direction.

The problem of how the body produces such a diversity of highly specific antibodies was dominated in the 1940s by the so-called instruction hypothesis. This proposed that antibodies are made as unfolded chains which, on contact with the antigen, wrap themselves around the antigen to form a "made-to-measure" antibody. This hypothesis fell when protein ▸

Monoclonals: a new industry is born

MONOCLONAL antibodies have three potential uses, in industrial processes, in diagnosis and in therapy.

Celltech, the British company formed to exploit the biotechnological discoveries of the Medical Research Council, was launched on the strength of a purification process based on monoclonal antibodies. It enables Celltech to produce relatively cheap quantities of interferons, the immensely promising antiviral and anticancer substances made by the body.

Most of the world's interferon comes from human cells grown in culture. But the quantities of interferon in the culture are so tiny, and the impurities so many, that extracting the interferon conventionally is slow and costly.

David Secher, who works in Milstein's laboratory and Derek Burke, then at the University of Warwick, created a hybridoma that secreted antibody to human interferon. Celltech exploits this in separation columns packed with beads to which the antibody is attached.

The culture fluid is poured into the column, and as it drips through, the interferon molecules, and nothing else, bind to the antibody. A second fluid poured through the column detaches the interferon from the antibody. The interferon that comes out is purer than that made available by any other method. The procedure is equally good for extracting interferon produced by genetically-engineered bacteria, and in principle could allow firms to purify many other substances.

Celltech was the first company to market a range of monoclonal antibodies for tissue-typing. This is a vital part of transplant operations—matching the antigens of donor and recipient.

All cells carry marker proteins on their surfaces. When marker proteins on donor cells fail to match those on host cells, the body rejects the foreign tissue. Tissue-typing means finding a healthy organ, made of cells which bear markers that match those of the host cells as closely as possible. It is a laborious task. But monoclonal antibodies can speed it up by identifying the required marker proteins in tissue from prospective donors.

Celltech makes a series of reagents for discriminating between the main types of human blood, A, B, AB and O. The company and its rivals are also developing other monoclonal antibodies to detect the identity tags of a variety of different kinds of cells.

SPL

SPL

Monoclonal antibodies at work. Left, the cells that make them are sorted and grown in cells; below, chambers containing the antibodies are implanted into a cancer patient

Transplant patients also stand to benefit from monoclonals after the tissue-typing has matched donor and recipient. There are two kinds of rejection. In the usual form, the host's immune system attacks the transplant. In so-called graft-versus-host reaction, cells from the graft attack the host. Rejection involves the production of T-cells by the immune system. An antibody to T-cells enabled doctors at Massachusetts General Hospital to detect the first signs of rejection in patients with new kidneys, and to treat them successfully.

Monoclonals have great potential in diagnosing certain diseases and perhaps the most eye-catching diagnostic application to date is for cancer.

Cancer cells are mutated ordinary cells, and as such may carry proteins unique to themselves. An antibody to one of these proteins can seek out the cancer. Radioactive tags may be attached to the antibody, so that they show up on an X-ray.

Some cancer cells secrete into the blood of sufferers, chemicals that are not secreted by normal cells, or produced in only small amounts. Ovarian cancer is number four in the rankings of cancer deaths among women in the US. Cancerous ovarian cells shed a protein called CA 125. Dr Robert Bast, working with a small company called Centocor in Philadelphia, developed a diagnostic kit which includes two antibodies to CA 125.

The first removes any CA 125 from a blood sample, and the second antibody binds to a different site on CA 125. This second antibody carries a radioactive label, so the amount of CA 125 can be measured by counting the radioactivity left on the beads.

Monoclonals antibodies could improve the diagnosis of all manner of conditions. A pregnancy kit is already available in the US. Companies also plan to develop detectors for spina bifida, hepatitis B, atherosclerosis, diabetes, and cancer of the colon.

The specificity of antibodies might also enable them to guide drugs to targets. Cancer cells, because they grow quickly, are susceptible to drugs that interfere with the growth of cells. But such cytotoxic drugs attack normal cells, too.

Now researchers, such as Dr Karol Sikora at the Ludwig Cancer Institute in Cambridge, have successfully attached a cytotoxic drug to an antibody directed specifically at cancer cells. The antibody carries the drug to the cancer cells, leaving other cells almost untouched.

This technique was once hailed as a "magic bullet" therapy. In fact it may turn out to prove more useful for "mopping up" cancer cells left after surgery or other treatment.

Jeremy Cherfas

▸ chemists discovered the final conformation, or shape, of protein molecules is determined solely by the sequence of amino acids that constitute them.

Jerne proposed the clonal selection theory of antibody formation. This holds that all antibodies exist from birth in lymphocytes and all the antigen does is to enhance the production of the antibodies. Clonal selection became a cornerstone of subsequent immunology. It led to Gustav Nossal's work in Australia, which showed that each lymphocyte produced only one kind of antibody—a concept that made possible Milstein and Köhler's technique of producing hybridomas.

Jerne says his next good idea was that somatic mutation had to exist to give lymphocytes their vast repertoire of antibodies because he "couldn't imagine that the many genes needed to code for antibodies could all be in the genome".

The idea eventually led to "jumping genes", the revolutionary observation that genes move around within the DNA.

Finally, Jerne gave a talk in Paris in 1973, when idiotypes, the five molecular families to which antibodies belong, had just been demonstrated. He suggested that antibodies could themselves be antigens and proposed that antibodies reacting with each other form an interacting control network within the immune system. The idea led to observations of control among different classes of lymphocytes, which explain many diseases and may, eventually, permit their treatment.

Jerne says this work will be the most important in immunology in the next few years. "The field is now a bit polarised by the DNA nucleotide-sequencing business, and finding genes for various proteins. We will have to go back to the physiology of lymphocytes interacting with each other."

Jerne is a Dane, although he was born in London. He did his doctoral work in Copenhagen and worked for six years at the SERUM Institute.

While directing the Paul Erlich Institute in Frankfurt, Jerne was approached by the Swiss pharmaceutical giant Hoffman-La Roche and asked if he would like to start a new institute in Basle.

Jerne says he built the Basle Institute of Immunology "according to my own ideas", and describes it as having a unique structure. There are no heads of department and "everyone interacts with anybody they want to".

With a move to Germany coming up Köhler will have plenty of uses for the prize money. Jerne, however, is at a loss: "You only need a piece of paper to do theoretical work so I don't need pay for any research. Besides I'm mostly retired. I live in a town near the Pont du Gard in the South of France. I haven't any idea what I'll do with the money. I don't even know how much it is." Presumably the Nobel committee will eventually phone and tell him. ☐

Whales flock to the tourists

GRAY whales are getting friendlier. A study of gray whales in Laguna San Ignacio in Mexico's Baja California, has found that since 1975 the lagoon's whale population has increased faster than the predicted rate of population growth. This area has been a centre of commercial whale watching since 1974.

Jeremy Cherfas

Boat meets whale, and friendship blossoms

The researchers, Maria Luisa Jones and Estelan Swartz of San Diego's Cetacean Research Associates, suggest that, far from being frightened off by the tourists, whales from other areas are deliberately coming to the lagoon to breed.

There are several reasons why the whales may like the lagoon. There are strict controls on the number and behaviour of tourist boats, which leave two-thirds of the lagoon undisturbed for calving mothers. And the boat operators take care not to frighten their quarry by chasing them or revving their engines.

One delightful side effect of the increased contact between the tourists and whales is the growing number of "friendly whales". They often circle around tourist boats, rub against them, allow passengers to lean over and stroke them, and frolic nearby. Before 1975 there were only a few recorded incidents of playful whales, but now, say the authors of the survey, such behaviour is "a commonplace event involving numerous whales and experienced by nearly every whale watcher".

One reason for their playfulness may be that this generation of whales, having escaped the harassment of the whaling industry, is not conditioned to be frightened by boats. Another explanation is that the behaviour of the boat owners, who follow the whales very slowly and only for a few metres at a time, teases the whales and arouses their curiosity.

But some observers think that the whales are more interested in the boats than in the people in them. Many seem to be attracted to idling engines; some repeatedly bump themselves against still propellors, and even take them into their open mouths. But they avoid speeding motorboats and non-motorised vessels such as kayaks and sailboats.

Why this fascination with boats? The answer may lie in the whales' acute sense of hearing: many of the sounds gray whales make are in the same frequency range as the noise of a slow-running outboard engine. ☐

Towards the frozen zoo

CINCINATTI Zoo announced the birth of a very special eland calf on Sunday last week. The antelope calf was conceived 27 months ago. After seven days in its genetic mother it was removed from her womb and frozen in liquid nitrogen. It then spent 18 months at a temperature of −196° C before being thawed and implanted into a surrogate mother eland cow. She gave birth to the healthy female calf after a further 270 days gestation. Dr Betsy Dresser, who leads the team that performed the operations, hailed this success as a giant step nearer the goal of a frozen zoo. ☐

Cashless shopping near

CASHLESS shopping in Britain came a step closer last week, but the banks and the shops are still arguing about who will pay for the equipment.

Two chain stores signed deals worth more than £4·5 million to buy terminals for cashiers from Nixdorf Computer of West Germany. The terminals can be linked to a bank's computers so that customers with a special card have their accounts debited automatically.

But the stores, Currys and Laura Ashley, have no immediate plans to allow people to buy goods in this way.

The industry is waiting for an agreement between the organisations that represent banks and shopkeepers on the design of a national "electronic fund-transfer" system. The banks, who would benefit the most, want to set up a national pilot scheme in 1986. But the Retail Consortium, which represents shopkeepers, says it does not see yet what its members would gain. There may also be problems over the legal status of the customers' cards. ☐

Alcohol makes babies small

PREGNANT women who take as little as one drink a day run a higher risk of having children with low birth weight than women who don't drink alcohol.

In the largest study of the topic, researchers at the National Institute of Child Health and Human Development ascertained the drinking habits of 31 604 pregnant women in California. They found that women taking one or two drinks a day during their pregnancy ran a risk 1·62 times as high as non-drinkers of giving birth to a baby among the lightest 10 per cent. A child born below normal weight runs a higher risk of disease and a shorter life than its heavier peers.

As the mothers' daily intake increased, the percentage of babies born light increased as well. This number ran from 5·8 per cent for non-drinkers, 6·9 per cent for those taking less than one drink; 11·6 per cent for one to two drinks; 16·8 per cent for three to five drinks; and 17·7 per cent for six drinks or more. For the three-to-five drinks a day group, the mean decrease in babies' birth weight was 165 grams below that of non-drinkers. ☐

Belting statistics

COMPULSORY seat belts do not save lives, a General Motors' symposium in Detroit was told last month.

John Adams, a geography lecturer at London's University College, said that although seat belts were "effective safety devices" in accidents, they did not reduce the total number of road deaths. He suggests that this was because drivers felt safer in belts, and drove more dangerously as a result.

The latest road accident figures for Britain show some support for Adams' theory. In the first quarter of 1984 the number of deaths to front-seat car passengers, who had to belt up in 1984, fell by 17 per cent compared to the same period in 1983. But the number of serious injuries to pedestrians caused by cars climbed by 6 per cent over the same period. ☐

In case of nuclear accident, stay put

Roger Milne, Snape

IN CASE of a serious accident, residents near future nuclear power stations in Britain may be told to stay put rather than run for their lives. This rethink of emergency planning strategy was indicated at the Sizewell B public inquiry last week.

Under plans for existing power stations all residents are evacuated. But at Sizewell B and any subsequent pressurised-water reactor (PWR) people may be told to stay indoors, close doors and windows, and shut off ventilation fans.

The possibility of a shift towards sheltering and away from evacuation emerged as the Sizewell hearing, at the Snape Maltings in Suffolk, was investigating the effectiveness of plans drawn up by the Central Electricity Generating Board (CEGB) and the emergency services to deal with a major accident at Britain's first PWR.

The arrangements currently planned for the PWR mirror those already in hand for existing gas-cooled stations. In essence, these provide for a 2-kilometre emergency zone around the nuclear site from which people would be evacuated if a serious accident, leading to an atmospheric release of radioactivity, happened at the power station.

These arrangements hang on the belief that people will be most at risk from a release of particulate fissile material, chiefly caesium and iodine. If ingested, iodine can cause cancer of the thyroid.

But recent American research suggests that, in an accident to a light-water reactor, such as the PWR, a gaseous release would be more likely. It is now thought that most of the iodine released in an accident would stay inside the contaminated building around the reactor. Iodine is chemically and physically reactive and would "stick" to the surfaces coated with paint, plastic and organic film. Also, condensation inside the reactor building during some of the most likely accidents would "wash out" many of the various fission products.

The new view is that with a significant amount of steam around, any release from most accidents at PWRs would consist mainly of inert gases. Last week, witnesses from the Nuclear Installations Inspectorate agreed that if iodine was not a major problem, "we have to look at sheltering from direct radiation from a cloud of radioactive gas". "We may have to review our plan" conceded Dr Samuel Harbinson, head of the NII's section assessing all aspects of radiobiological safety.

Pete Addis

Emergency plans at Sizewell A: When the reactor (above) goes wrong, the second-world-war switchboard takes charge

In its written evidence to the inquiry the NII says that evacuation, particularly from inside the emergency zone, is preferred partly to "ensure arrangements are not unnecessarily complex". But, if sheltering ultimately becomes the major plank of emergency procedures, there will be growing pressure for the public to be told in advance exactly what to do in the event of an accident. At the moment emergency plans are not publicised.

Judging by his comments at the inquiry, the inspector, Sir Frank Layfield QC, believes people living close to a reactor would welcome a leaflet indicating what action they should take during an accident. The NII and the emergency services are not convinced. They claim people might mislay the information or be unduly alarmed.

Ironically, the European Community has just introduced legislation requiring the publication of emergency plans for all residents around hazardous industrial sites, such as chemical works. This legislation, however, does not apply to nuclear sites.

The nuclear industry and the NII have repeatedly told the hearing that, providing the PWR is designed to incorporate sufficient "engineering safeguards", the likelihood of a serious accident involving emergency measures for the public living near the site can be discounted. ☐

Generating board invests again in AGRs

THE CENTRAL Electricity Generating Board (CEGB) is putting cash behind its decision to hedge its bets over future nuclear power station orders. This week the board announced that it is asking the National Nuclear Corporation (NNC) to a study how easily its latest, half-built advanced gas-cooled reactor (AGR), Heysham 11, can be replicated.

Significantly, the announcement was made at the Sizewell B public inquiry, which is considering the CEGB's plan for a pressurised-water reactor (PWR). Until recently it was assumed that the board had lost all interest in AGRs.

News of the contract will be welcomed at NNC, where redundancies among its AGR scientific staff, based at Whetstone near Leicester, were feared.

The CEGB insisted this week that while it believed it was prudent to maintain its interest in AGRs in case Sizewell B was blocked the PWR remained a better economic bet than an AGR. ☐

No flies on Britain's bee inspectors

REPORTS of the imminent decimation of British bees have been greatly exaggerated. The parasitic mite *Varroa jacobsoni* is expected to be discovered in British hives in the near future. Contingency plans have already been drawn up by the government and research aimed at containing the parasite has been under way for a number of years.

The adult varroa female looks like a tiny crab; it is reddish brown, has eight legs and can be seen with the naked eye. Males are much smaller and remain well hidden in sealed brood cells. Traditional host to the mite is the Eastern honey bee (*Apis cerana*) but it spread to the Western honey bee (*Apis mellifera*) when beekeepers took *A mellifera* colonies to the eastern USSR, Japan and south east Asia.

Seven years ago, varroa appeared in West Germany and, assisted by the long distance flight patterns of bees, soon infested hives in Italy, eastern France and northern Greece. The mites' passage, across the Channel is acknowledged as being only a matter of time.

The nature of the threat of varroasis is a controversial and emotive issue among British beekeepers. Widely conflicting reports of the damage are aggravated by a lack of information.

In cold climates, bees are immobile for long periods of the year and often become vulnerable to the varroa. The mite feeds on the blood of immature bees, but only where infestation is heavy do the bees emerge deformed or the larvae killed.

Drone larvae are more susceptible than worker larvae, and the mature female mites attach themselves to and escape with the emerging bees. Adult bees are mainly a means of transport for the varroa.

There are about 60 British bee officers. By 1985 they will be trained to look for varroa as well as usual bee diseases.

Destruction of hives to control the parasite is often not necessary. Pesticides would kill the bees as well. A method of control being tested in the Netherlands, and developed in China, is the heavy smoking of the hives, with nicotine. ☐

There's a new girl on our block

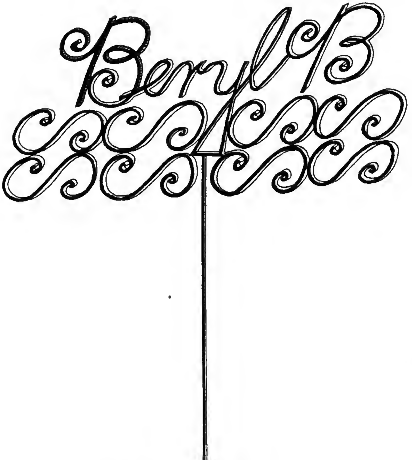
Beryl B is her name. And though she's yet to make her formal debut, Beryl B is already earning her keep, producing oil from Block 9/13 – Mobil's biggest operation in the British North Sea.

Newcomer though she might be, Beryl B has great connections. In only eight years, her elder sister platform, Beryl A, has produced more than 200 million barrels of crude oil.

Between them, the two Beryls will ultimately bring to the surface about 135,000 barrels of oil every day. That's nearly 10 percent of this country's total daily needs.

Or, to look at it in fiscal terms, it's roughly equivalent to a daily contribution to the Exchequer of £2 million.

That's big money to be generated by such a pair of comparative youngsters. But then, Mobil and its fellow venture participants brought up the Beryl girls to be a sister act that's hard to follow.



Mobil | Beryl B

Mobil North Sea Limited

Pirates are winning battle of the airwaves

Barry Fox

South London's TV pirates pose for Fleet Street

LEN

AIRWAVE pirates are running rings round the Department of Trade and Industry (DTI). Its engineers, aghast at what is happening in the Netherlands, fear that piracy will escalate when there are more cable-TV stations in Britain. Last week, the DTI made its first major raid since it took on British Telecom's responsibility for clearing the pirates off the air in August. However, it failed to close down its target, a pirate TV station which had been flaunting itself to the press. The DTI admits it bodged the TV raid, but says it is handicapped by limited resources and did at least catch one suspected radio pirate and confiscate some transmitters.

For the past five years, gaps in the VHF radio waveband in Britain have been filled by pirate radio stations, especially in the London area. Technically, there is no difficulty for inspectors in finding the pirates with a detector van and a directional aerial. When two, or ideally three, vans take a bearing at the same time, they can find the transmitter's likely location. The engineers then simply look for a tell-tale roof or mast aerial.

Enthusiasts of citizens' band radio use the same technique to play a game of hide-and-seek, which involves tracking down a car equipped with a transmitter which is acting as a "hare".

A TV pirate is not as free as a radio pirate in deciding where to base a transmitter. Aerials for TV receivers are directional; all the domestic aerials in a town must be pointed at the local transmitter. So a TV pirate must operate from that area, thereby giving away the general location of the illegal transmitter.

Until August, British Telecom employed 270 engineers in its Radio Investigation Service (RIS), to detect interference and locate pirates. The radio pirates foiled the RIS by broadcasting at weekends or in the evenings, when inspectors did not want to work. The government promised action and moved the inspectorate to the DTI.

The civil service pays lower salaries than British Telecom, and there is less money for overtime, even if the engineers want to work it. So although the penalty for piracy is a fine of £2000 or 3 months in jail, along with the seizure of expensive transmission equipment, the pirates have generally been safe outside civil-service hours.

By tightening the law to allow arrest and seizure of equipment, the government has, however, increased the risk of violence to inspectors when they raid a pirate. Low-paid radio engineers not surprisingly now insist on police help. This slows the detection process to a snail's pace.

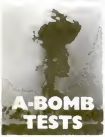
The inspectors know that their problems are only just beginning and that the spread of cable TV will make life even harder. To broadcast to a wide area, a pirate needs powerful, expensive equipment. In Holland, unauthorised broadcasters have found a simple solution. They beam a low-power signal from close range onto the receiver aerial of a cable relay station. The electronics then lock onto the pirate programme and re-broadcast it instead of the intended legitimate programme.

The BBC and ITV in Britain have already suffered hijacks at their relay transmitters and now use secret "tone codes" to block out illegitimate broadcasts. Cable stations, however, cannot do this because they rely on the much simpler technique of picking up routine broadcasts, amplifying them and sending them down a cable to subscribers' homes.

The Dutch government insists that each cable station must employ someone to keep a constant watch on all the TV channels it is relaying and switch off any channel that is hijacked. But on radio piracy the Dutch have had to admit defeat. There are now so many Dutch radio pirates that they can hijack with impunity because the cable stations would otherwise be continually switching channels on and off. ☐

Commission in disarray over radiation evidence

INQUIRY



THE AUSTRALIAN Royal Commission investigating Britain's atomic tests there in the 1950s was in disarray this week. Witnesses are refusing to give their evidence because one member of the commission was a member of an earlier inquiry which dismissed any health fears surrounding the tests.

The commission member, Jill Fitch, after first agreeing to resign, has now insisted on staying put. A court case over her role is pending and it is unclear whether the commission can continue until that is out of the way

The row has arisen because Fitch was a member of Australian Ionising Radiation Advisory Council (AIRAC) which produced the original report which dismissed fears of inadequate safety precautions. But this report was subsequently attacked in a second study, prepared by Professor Charles Kerr, for the Australian federal government. Kerr's report in turn led to the royal commission being set up. The commission began hearing evidence last month.

Now AIRAC chairman Professor Max Clark has hit back, saying that Kerr's report is misleading. Clark says Kerr appears to have set out deliberately to discredit the council. "The report contains numerous internal contradictions and apparent misunderstandings," he says.

Clark's forthright criticism comes in letters to the Minister for Home Affairs and the Environment, which were tabled in parliament last week.

The letters have provoked a political storm. Veterans' groups have now started a court action to have Fitch removed from the commission on the grounds of a conflict of interest. Fitch has since resigned from AIRAC, but refuses to stand down from the commission pending the court ruling.

Clark says that none of the Australian officers involved in the atomic tests received more than a fraction of the permitted dose. "The council does not consider the estimates are in error by an order of magnitude. However, even if they were, there still would not have been excessive exposure of humans to radiation."

Clark admitted there were a few discrepancies in figures and these had been amended in the light of new evidence from Britain. He also criticised Kerr's reliance on anecdotal evidence saying that AIRAC had attempted to achieve the highest levels of scientific objectivity.

During the hearings so far, the commission has heard wide-ranging evidence from veterans alleging exposure to high levels of radiation. The commission has heard that unpressurised aeroplanes were flown through the fall-out cloud to take measurements.

Evidence has also been given of an incident where 200 army staff were threatened with court martial if they told outsiders of an incident where a family of Aborigines was decontaminated after wandering into the test site.

Last week the commission was told of a black mist which caused acute illness and some deaths among Aborigines. Clark said of this evidence that the description "with the account of healthy dogs apparently unaffected by the black mist, eating the human corpses, makes it clear that whatever the illness it was not due to radiation exposure". **Jane Ford, Canberra**

AIDS virus is spreading and mutating

Christopher Joyce, Washington DC

INFECTION with the virus that causes AIDS (acquired immune deficiency syndrome) is probably 30 to 50 times more common than the disease itself. This is one finding from preliminary evidence gathered in the US and reported last week at a meeting of the American Society of Microbiology held in Washington DC.

Now that the AIDS virus, called HTLVIII (human T-cell leukaemia virus III), has been isolated from semen and saliva, fears about the spread and control of the virus are growing again.

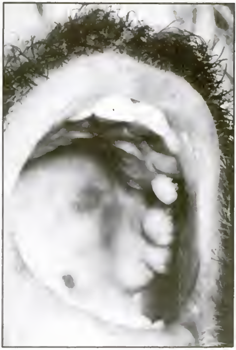
Dr Robert Gallo of the National Cancer Institute at Bethesda in Maryland, who first isolated the HTLVIII, said: "We don't have proof that heavy kissing is a major route of transmission ... but I think we are still ignorant about that".

Cases of AIDS have doubled in the US over the past year, and scientists hunting for a weapon to fight the disease expect the rate to increase. According to Dr James Curran of the US government's Centers for Disease Control in Atlanta, Georgia: "Infection with the virus is far more common than reported AIDS cases, with probably a minimum of a quarter million people who, past or present, have been infected with the virus."

Evidence so far indicates that many people carry the antibodies to HTLVIII, indicating that they have been infected at some time. Perhaps as many as 10 per cent or more of those infected will get AIDS, although scientists say they still cannot predict this ratio with certainty. To date, in the US, AIDS has killed about 3000 of the 6350 people who have come down with any of the several diseases that typify the syndrome. Of 81 cases in Britain, 36 have been fatal.

These findings are mirrored in West Germany, according to Dr Fritz Deinhardt of the Department of Medical Microbiology and Hygiene at the University of Munich. Several groups in Germany found that about 30 per cent of healthy homosexuals had antibodies to HTLVIII. Deinhardt also noted that, while not one haemophiliac tested in 1978-1979 registered the antibodies, a large percentage tested this year did.

Gallo reported that the virus is very heterogeneous, with perhaps 100 genetic variations found to date. The genome of the virus "is undergoing more rapid change than we thought", Gallo said, though not as quickly as influenza viruses change and adapt. Gallo added that there is no evidence yet that genetic variation in the virus would require more than one vaccine.



St Mary's Hospital

Kaposi's sarcoma on the roof of the mouth: the AIDS virus has now been found in saliva

HTLVIII kills certain cells of the immune system which are responsible for initiating and regulating the production of antibodies against invading organisms. The result is that the victim is susceptible to opportunistic infections that are rare in healthy people. Attemps to reconstitute the immune systems of AIDS sufferers with the likes of gamma interferon, interleukin II (also known as T-cell growth factor), bone marrow transplants and histocompatible lymphocytes have not worked. The activity of the immune system becomes moderately enhanced but there is always a return to a depressed state.

Meanwhile the search for a reliable test for HTLVIII continues. Gallo mentioned that a test for HTLVIII antibodies in blood supplies is expected in November. Screening blood for the presence of the virus is important if the disease is not to spread to people needing blood transfusions—the group most at risk is the haemophiliacs.

British scientists hope to have a blood test for HTLVIII antibodies in pilot studies in a matter of weeks. If all goes well the test could be introduced to blood transfusion centres all over Britain within 6-12 months. The test is the result of a joint effort between scientists at the Middlesex Hospital Medical School and the Chester Beatty Laboratories in London and took just eight weeks to devise.

A purpose-built laboratory at the Middlesex Hospital is all set to produce HTLVIII antigen. Once the laboratory has passed safety checks, scientists will assess the efficiency of the test as a screen for HTLVIII antibodies.

For commercial reasons, any test for AIDS introduced in Britain would have to be based on a British isolate of HTLVIII. The current test is based on an isolate from Gallo's laboratory, supplied for research only. Luckily, Dr Robin Weiss at the Chester Beatty Laboratories already has one British isolate of HTLVIII.

Testing would have to be introduced to all centres at the same time, and there is the problem of what to do when an individual is found to be HTLVIII positive. As yet, there is no knowing how many people with the virus in their blood will develop the full syndrome. □

AIDS in Africa: a heterosexuals' disease

IN CONTRAST to the US and Europe, AIDS in central Africa appears almost entirely among heterosexuals. Nor do haemophiliacs, intravenous drug users or their spouses appear at special risk.

According to Dr Nathan Clumeck of the University of Brussels, AIDS in central Africa attacks men and women at a ratio of 3:2. Heterosexual promiscuity is the most important risk factor, and prostitutes are the most likely reservoir of the disease.

"The disease is rampant among the upper classes in Africa," declared Dr Robert Gallo, who first isolated the virus. At a meeting of microbiologists in Washington DC last week, Clumeck speculated that: "What's happening now [in Africa] could be the future in the States."

The discovery last May that the AIDS virus is a member of the HTLV family prompted scientists to look for the presence of antibodies against HTLVIII in blood samples taken from central Africans, since it is in this region that Gallo believes the HTLV family originated.

The evidence from antibody studies shows so far that the virus is most prevalent in Zaire.

Field studies of the prevalence and characteristics of Kaposi's sarcoma in central Africa, however, are helping to pinpoint further the origin of HTLVIII. Kaposi's sarcoma is a relatively rare cancer outside of Africa, but it is the most common opportunistic disease affecting AIDS victims—another reason why scientists believe the virus originated in Africa.

Robert Downing, a microbiologist at the Centre for Applied Microbiology and Research at Porton Down, believes that HTLVIII-induced Kaposi's sarcoma may be different from the type of Kaposi's normally occurring in Africa. The classical form of the disease results in nodules and lesions on the skin, usually of the extremities. The disease is not usually fatal and frequently regresses completely.

In AIDS victims, however, the cancer rarely affects the limbs. It is found instead in the mouth and gut. The disease is much more aggressive and resistant to chemotherapy.

This type of Kaposi's, according to Downing, is now turning up in Zambia. Of 32 patients studied in Lusaka, 13 had this atypical Kaposi's. They were all well educated and of a higher social class than 19 with typical disease. None of those with classical Kaposi's died, compared to eight in the "atypical Kaposi's" group.

Downing, with the help of Robin Weiss, of the Institute of Cancer Research Chester Beatty Laboratories in London, looked for antibodies against HTLVIII in 35 patients with classical Kaposi's. Only five were positive and two of these were from Uganda. Because Zambians with typical Kaposi's proved to be consistently positive for HTLVIII antibodies, Downing believes that the disease is new in Zambia. He suggests that the virus was around much longer in Uganda. **Omar Sattaur**

Spanish poisoning: was cooking oil really to blame?

Debora MacKenzie, Geneva

Popperfoto

Victims of the poisoning demonstrated for a better deal

THE CONTINUING scientific controversy over why more than 300 Spaniards died of some kind of food poisoning in 1981 erupted again last week. As the World Health Organisation (WHO) published a new report confirming that contaminated cooking oil was to blame, two members of the Spanish government's own commission of inquiry resigned. They claimed that the oil theory was wrong and one doctor involved in the case since the beginning now believes that pesticides sprayed onto tomatoes could be to blame.

Meanwhile, representatives of the thousands of people still suffering from the poisoning told Spanish newspapers they are afraid the authorities' reluctance to examine other explanations may keep the cause, and a cure for their affliction, from ever being found.

The outbreak began on 1 May 1981, when people started arriving at hospitals throughout northern Spain and in the poorer areas of Madrid. They suffered from acute breathing problems, fever, rash, pain and vomiting. By early June, 600 people a day were being admitted.

Those who survived went on to develop nerve damage, muscle wasting, hardened skin, atrophied salivary glands, and weak bones in what came to be known only as the "toxic syndrome". Of the 20 178 affected, 341 have died, the latest last February. Thirty are still in hospital.

Yet scientists have still not tracked down the cause of the disease, or found any cure. Since it spread chiefly within families, and seemed to be linked with people's eating habits, food poisoning was suspected very early on. Eventually, the official pronouncement was that the culprit was illegal, impure cooking oil, which the government started to recall by July.

The WHO reported last week: "Nine separate case control studies that compared patients with unaffected people showed a remarkably strong and consistent association between the development of the syndrome and consumption of food oil purchased from itinerant vendors."

But other scientists point out that only nine families were studied in reaching this conclusion. There are many more, chiefly in Catalonia, where the suspect oil was consumed with no ill-effect. Moreover, they say that illness broke out in areas where adulterated oil, illegally refined from rapeseed oil intended for industrial use, was never sold.

One problem, says the WHO, is that during the initial period when the recall of suspect oil began, people brought in 3000 tonnes of cooking oil, some deliberately contaminated, to exchange for the government's olive oil. Samples were confused, and scientists cannot now establish clear connections between samples, contaminants and the disease.

But the WHO reports that the sharp drop in new cases in mid-June coincided with the government's warning about oil, that this "offers a possible explanation of the sudden disappearance of acute cases, and no other possibility (besides oil) has been substantiated by supporting evidence".

But the WHO's own graphs show that new cases began to fall in mid-June, two weeks before the warning and recall began.

Files on 600 000 people in the affected area have not yet been analysed, and elsewhere in its report the WHO suggests that these may settle whether the fall in new cases was due to the recall of oil. Stanislaw Tarkowski, who headed the inquiry, says the decline could also have been because the toxin in the oil, whatever it was, was short-lived.

This could also explain the total failure so far to induce the syndrome in any experimental animals with any suspect oil, or with the anilide compounds that were thought to be the toxins.

But that guess is rendered doubtful by work at Unilever's research laboratories in Holland. There, where attempts to repeat the illegal refining process produced no anilidesy, only "higher molecular weight aniline derivatives of currently unknown identity and toxicity" which might have formed anilides during storage. There is hope that these might turn out to be the elusive toxin.

But Antonio Muro, who was dismissed from the First of October Hospital in Madrid early in the epidemic for first suggesting that the problem was food poisoning, thinks the toxin was an organophosphorous pesticide. He says organophosphorous toxicity is similar to the wasting syndrome, is long-lived and results from inhibition of the enzyme acetylcholinesterase, which is essential for nerve function. He suggests that residues in tomatoes might have combined with some other chemical to promote the sudden outbreak.

Reports in the Spanish press say this hypothesis cannot be verified clinically because drugs the patients are on also inhibit the enzyme. So the argument depends on epidemiology. "We listened to this hypothesis, if you want to call it that, for two hours last May," says Stanislaw Tarkowski, who headed the WHO inquiry. "We didn't find it convincing." The WHO report describes the evidence for any other hypothesis to explain the syndrome as "anecdotal".

But there are enough inconsistencies and unknowns in the data about the routes taken by oil vendors, who ate oil, and who became sick, to provide ammunition for both sides in the debate □

Angling papers ban lead-free advert

TWO ANGLING magazines have refused to carry an advertisement offering a free sample of "safe" lead-free fishing weights. The advertisement, placed by the International Fund for Animal Welfare (IFAW), draws attention to the damage done to swans by ordinary lead fishing weights, and was accepted without comment by three other angling monthlies.

Minsters say they want lead weights phased out by 1986, if possible voluntarily, otherwise by legislation.

John Ingham, publisher and editor of *Anglers Mail*, which is owned by IPC, says that he refused the advert because it was "too sensational". He invited IFAW to amend the copy. Ingham agrees it is "undeniable" that lead weights kill swans. "The death of one swan from lead weights is one swan too many," he said this week.

By contrast, the editor of *Angling Times*, Allan Haines, says that statements in the advert "were bordering on fiction". He denies that anglers' lead weights are a factor in the poisoning of swans. Haines says the swans pick up lead salts from exhaust fumes and water weeds.

"That is nonsense," said Chris Perrins, director of the Edward Grey Institute of Field Ornithology at Oxford and the man responsible for pinpointing the threat to Britain's swans. Perrins says that there is enormous variability in blood lead levels in swans, and that the highest levels are associated with the presence of masses of lead weights in the bird's gizzard.

The alternatives to lead shot are based on tungsten and have proved safe in trials on mallard ducks. They are currently twice the price of lead weights, but the price will drop as sales rise. □

This is all it takes to kill a swan.
This is all it takes to save one.

Beryl's star turn

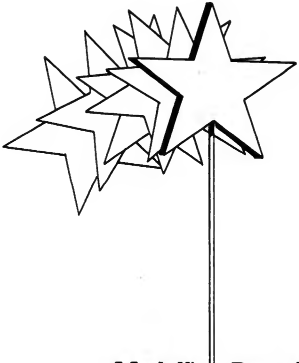
Though not among the North Sea giants, Mobil's newest offshore production platform isn't exactly sylph-like either. Twice as heavy as the Eiffel Tower, and with a profile that could, at best, be described as functional, Beryl B is hardly conventional star material.

Nevertheless, last year she performed like nothing short of a prima ballerina when her turn came to take centre stage in Britain's enduring North Sea spectacle.

On a misty day in May the 14,000 tonne steel jacket – 130 metres tall and 60 metres wide – slid from her tow-out barge and pirouetted down to the seabed. Then the artistry began. With tolerances of only ¾ of a degree, Beryl B delicately extended specially designed locating pins to lower herself with exacting precision over a pre-positioned drilling template. Illuminated by strobes and captured on television monitors, the whole performance took a suspenseful eight hours. And opened up a new era in offshore technology and techniques.

Just 23 days later the platform structure was, to all intents and purposes, complete.

Beryl B's lightning virtuosity might not have brought an audience to its feet at Covent Garden. But then, as Mobil and its fellow venture participants can attest, the North Sea is hardly Swan Lake.



Mobil | **Beryl B**

Mobil North Sea Limited

Gassing badgers fails to stop TB

J. A. Bailey/Ardea

Badgers set to win gassing argument

A REPORT published today attacks government policy for dealing with badgers and tuberculosis (TB) in cattle. The Badger Working Group of Wildlife Link, a consortium of conservation bodies, points out that "thousands of badgers and cattle have been killed—yet the desired objective of eliminating the disease in cattle has not been achieved". It suggests that the best solution may be to do nothing other than simply slaughter infected cattle.

The report* is aimed at the Bovine Tuberculosis Review Group, recently convened by the Ministry of Agriculture, Fisheries and Food (MAFF) to "conduct an overall review of the problem of dealing with badgers infected with bovine TB". The group expects to publish a report within a year.

The fight against TB in cattle has been very successful. The incidence has dropped from 40 per cent in the 1930s to less than 0·01 per cent today, except in areas of south west England, where it stubbornly remains at around 10 times the national average. The discovery in 1971 of a tuberculous badger on a Gloucestershire farm that had infected cattle offered a plausible reason. MAFF began to gas badgers in the vicinity of tuberculous cattle in an attempt to eradicate the disease.

The Badger Working Group accepts that the badger is one factor in the high incidence of bovine TB in the south west. But it says that there is "no evidence" that MAFF's badger control policy has had any effect on the incidence of TB in cattle. Furthermore, and contrary to Lord Zuckerman's claim in his 1980 report for MAFF, there was no geographical spread of the disease during a moratorium on gassing. These two conclusions undermine the rationale of the badger control policy.

Experiments in 1982 revealed that 2000 parts per million (ppm) of cyanide gas were required to kill badgers in a sett within one minute. To do so within 25 minutes needed 194 ppm. As MAFF had known since 1979 that cyanide levels during gassing operations averaged about 150 ppm, gassing was stopped as inhumane.

Current MAFF policy is to trap or snare badgers near infected herds and then shoot them. The report accepts that this is providing valuable extra information, but points out that as gassing had no effect on TB in cattle, the trapping programme should be very carefully evaluated in 1988, after it has run for six years. If there has been no change in the incidence of TB, it should be abandoned.

The Badger Working Group also questions MAFF's exclusive focus on badgers as a reservoir of TB. Cats, dogs, deer, and especially pigs, can also harbour the disease. In many of the problem areas of the south west pigs run freely with cattle. The report recommends that where cattle have TB, other farm animals should be tested and, if necessary, slaughtered.

Perhaps the biggest objection to MAFF policy is that it offers no basis for assessment. All outbreaks of TB associated with tuberculous badgers are treated in the same way, by killing the badgers. The report recommends that "no badger-interference" zones be set up around infected farms to see whether killing badgers has any effect on bovine tuberculosis.

Farmers, who at present receive 75 per cent of the market value of any infected cattle slaughtered, would need some inducement to run the risk of further outbreaks of TB. The report suggests that this be in the form of research assistance grants from MAFF to farmers who cooperate. It also points out that repeated outbreaks of TB are *more* common on farms where badgers have been gassed.

In the end, financial considerations may sway MAFF more effectively than anything else and allow it graciously to abandon a policy that has achieved little except to generate controversy. Badger control cost an estimated £405 000 a year between 1976 and 1982, and current costs are almost certainly higher because trapping is more expensive than gassing. Compensation accounts for £130 000 of that sum each year, and it may be that if there is no change in the incidence of TB in cattle, this would be an acceptable amount, saving money, face, and badgers.

MAFF has a statutory duty to "eradicate" tuberculosis in cattle. It has a similar duty towards another disease, brucellosis, which causes abortions in cattle and flu-like fevers and chronic polyarthritis in humans. In 1982 MAFF reported that England and Wales were "now for all practical purposes" free from brucellosis. Notwithstanding this statement, there are currently about 6000 cases of brucellosis diagnosed each year. With fewer than 1000 cases each year of TB in cattle, MAFF could likewise declare TB eradicated and abandon its search for ways to decrease its incidence still further.

MAFF's response to this suggestion was to repeat its declared policy of testing for both TB and brucellosis and slaughtering any reactors. The ministry offered no reason when asked why it discriminates between the two diseases. ☐

***Badgers, cattle and bovine tuberculosis** is published by the World Wildlife Fund, 11-13 Ockford Road, Godalming, Surrey GU7 1QU.

New curbs needed for pests

BRITAIN should cut its use of pesticides, and find other methods of control, according to an official report now being considered by the government.

The report comes from the Crops Protection Committee, which was set up in February this year to look at ways on controlling pests in stored food, for the Ministry of Agriculture, Fisheries and Food (MAFF). The committee's members include manufacturers, academics and government scientists.

The report, which was sent to the government earlier this month, says that the emphasis should be switched from pesticides to good housekeeping. This would help to protect the environment, and lessen the risk both of pests becoming resistant and of harmful residues in food.

According to the committee, more than 10 per cent of stored grain is at risk from infestation. Fumigation is the most popular method of tackling pests, but insects are becoming more resistant to the chemicals.

The committee says that better stock control and checks to catch an infestation are more efficient than relying on fumigation. The committee says that other methods of control should also be studied, such as hormones, which interfere with the ability of insects to reproduce.

The MAFF's research laboratory at Slough has pioneered hormone controls and developed chemical copies of hormones, known as analogues. Analogues are now being produced commercially and used against such pests as the almost indestructible Pharoah Ant, which plagues hospitals, homes and commercial buildings alike.

The report's recommendations include:

- more research to discover why some buildings are unattractive to mice and rats;
- the development of new poisons for rodents to replace the present anticoagulents to which rodents are becoming immune;
- the reinstatement of public health pest control research at Slough, which looked at common pests such as the house fly and cockroach until it was closed by MAFF;
- more government and industry cooperation over joint research programmes. ☐

Beryl's handy with a drill

And that means that Mobil's newest platform in the North Sea doesn't have to rely solely on men to do a very dirty – and potentially dangerous – job for her.

Instead, Beryl B tackles part of the task herself, using equipment known as an iron roughneck. This innovative device grapples with enormous lengths of drill pipe, connecting them together as drilling progresses at speeds of up to 150 rpm. Skilled (and human) operators supervise from the sidelines as Beryl gets on with an important job. The result is increased speed, greater efficiency and – most important of all – vastly improved safety.

As far as Mobil and its fellow venture participants are concerned, those have been the overriding objectives in her entire drilling operation. Noteworthy too are a new top-drive drilling system and innovative use of aluminium drill pipe.

Beryl B's tendencies are, in short, distinctly high-tech. And since she began producing oil on 6 July – under budget and ahead of schedule – her exacting demands have paid off.

It's no wonder that Beryl B stands so tall among her peers in the North Sea: all 225 steely metres of her.

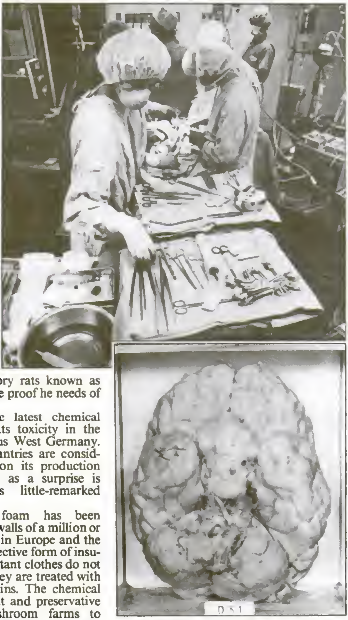
Mobil Beryl B

Mobil North Sea Limited

Coming to terms with a carcinogen

Formaldehyde is a natural chemical in the human body. But natural does not mean safe and, this autumn, fears are growing of cancer caused by a chemical we encounter in clothes, newsprint, cosmetics and within ourselves

Fred Pearce



NOVA

London scientific photos

Formaldehyde is a disinfectant in the operating theatre, and a preservative in the lab

SOMETIME in 1977, 240 rats from North Carolina settled down to two unhurried years lounging in laboratory cages and breathing dilute fumes of formaldehyde gas. The fate of those rats is almost the sole reason why formaldehyde may soon be banned from a wide range of products that account for up to 8 per cent of the gross domestic products of the US and West Germany.

Douglas Adams, in his book *The Hitchhikers' Guide to the Galaxy*, mused that human society was an elaborate scientific experiment set up by white mice. If he will swap the mice for a breed of laboratory rats known as Fisher 344, he has all the proof he needs of their omnipotence.

Formaldehyde is the latest chemical to excite fears about its toxicity in the US and Green-conscious West Germany. This autumn, both countries are considering stricter controls on its production and use. What comes as a surprise is how ubiquitous this little-remarked chemical is.

Urea-formaldehyde foam has been pumped into the cavity walls of a million or so homes and caravans in Europe and the US. It is a cheap and effective form of insulation. Most crease-resistant clothes do not need ironing because they are treated with formaldehyde-based resins. The chemical is used as a disinfectant and preservative everywhere from mushroom farms to mortuaries. Formalin, a 40-per-cent solution with water, is ever-present in hospitals, in biology laboratories where it preserves specimens, and in the fur and leather processing industries. Resins turn up in tyre factories, in industrial filters, in orthopaedic casts and photographic paper. They are a component of glue and plywood and of wood panels, and crop up in newsprint and cosmetics. Formaldehyde is found in high concentrations in cigarette smoke.

Doctors have known for many years that formaldehyde at very low concentrations can cause dermatitis and lung complaints such as bronchitis and asthma. One Soviet study suggests that it may lead to menstrual disorders and complications in pregnancy, though nobody in the West has followed this up. But the lives and deaths of those North Carolina rats have lead many people to label formaldehyde as an agent for cancer in humans.

Because the chemical is so widely used, the possibility that it may cause cancer excites widespread concern. But it also makes it very difficult to devise a study that could pin down the truth. Giant chemical firms, and scientists with a mission to hunt down and ban carcinogens, both see the row over formaldehyde as a test-case for public policy-making.

But first, the rats. Experimenters working for the Chemical Industry Institute of Toxicology (CIIT) in the US gathered together 1000 rats and divided them into four groups. The first group was herded into cages where the animals were exposed to air containing 14·3 parts per million (ppm) of formaldehyde for six hours every day, five days a week for two years. (This regime no doubt avoided paying overtime to the technicians who turned the gas taps on and off, but it also approximated the regularity of exposure likely in a factory.) A second group of rats was given a dose of 5·6 ppm formaldehyde and a third a dose of 2 ppm. The fourth group acted as a control.

For the first year the rats thrived, but then the bodies began to pile up in the cages exposed to 14·3 ppm. Most of the deaths were caused by tumours that grew in the thin bones, known as turbinates, that surround the rats' nasal passages.

At the end of the experiment, 95 of the original 240 rats exposed to 14·3 ppm had contracted these tumours. After allowing for other losses among the rats, this represented a 43-per-cent incidence of this rare tumour. Of those rats exposed to 5·6 ppm, 3 rats (or 1·5 per cent) formed nasal tumours, while there were no cases among the 2 ppm or control groups. The expected "spontaneous occurence" of such tumours among Fischer 344 rats was 0·04 per cent.

A follow-up study on mice was inconclusive. Only two of the animals got nasal tumours, but many of them died before the end of the experiment after gang battles broke out in the communal cages. The CIIT's original rat study remains the only unequivocal evidence that formaldehyde gives rats, or any other mammal, nose or any other cancer.

How do we interpret these results in terms of human risk? Should we wait for evidence of formaldehyde's cancer-causing potential in humans, or assume the worst until there is compelling evidence to the contrary? If the latter, when does the evidence become compelling? Proving a negative is not exactly easy.

Britain's Health and Safety Executive (HSE) published its own toxicity review of formaldehyde in 1981 and sticks by its conclusion then that "there is at present no evidence that exposure to formaldehyde has produced cancer in humans".

Other watchdogs are less sanguine. In May this year, the Environmental Protection Agency (EPA) in the US decided to give the chemical "priority status" for regulatory assessment. Under the Toxic Substances Control Act, the EPA has to do this when it finds "a reasonable basis to conclude that a chemical presents a significant risk of serious or widespread harm to human beings from cancer, gene mutations or birth defects".

The EPA has already given notice that it wants to act in two areas: to make life safer for workers in the clothing industry who treat clothes with formaldehyde resins, and to protect people who live in caravans and houses encased in formaldehyde insulating foam.

In West Germany, the Greens have taken up the issue and played formaldehyde alongside dixoin as a prime chemical hazard. Earlier this year, the city authorities in Wiesbaden closed three nursery schools after glue in wood panelling on the walls was found to be giving off formaldehyde fumes.

Then the Greens discovered that three federal authorities, covering health, worker protection and the environment, had drawn up a report last autumn which argued that formaldehyde should be listed as a carcinogen (cancer-causing agent). The German health minister, Dr Heiner Geissler, was caught on the defensive. He denies a cover-up and promised to publish the report before the end of the year. Geissler added strong hints that new controls on formaldehyde in homes, hospitals and factories were on the way.

The lobbying in Bonn and Washington this autumn will be intense. People in Washington still remember the infighting in 1982, when the Consumer Product Safety Commission went out on a limb and decided to ban the installation of formaldehyde foam insulation. Industrialists, represented by the Formaldehyde Institute, accused the commission's scientists of misleading the commissioners. One of those commissioners said at the time: "In my eight years as a member of this agency, never before have I witnessed a more concerted and unfair attack on the personal integrity of our staff."

The stakes are high. In the US, some 50 chemical works make more than 3 million tonnes of formaldehyde every year. The West German chemical giant BASF is the world's largest producer, making 400 000 tonnes a year, worth more than 1 billion Deutschmark.

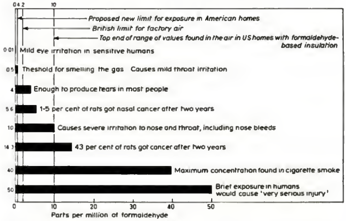
BASF claims that more than 3 million German jobs depend, one way or another, on the manufacture of products that contain formaldehyde and that "there is no acceptable substitute". Business analysts have since undermined that implied threat to jobs. In August, The *Wall Street Journal* reported that, far from costing jobs, a ban on products containing formaldehyde could boost German industry by acting as a barrier to imports containing the chemical.

The chemical companies wheel out scientists to argue that the fate of a few laboratory rats is no basis for regulating such a vast industry. "Epidemiology, not animal studies, is the most accurate and definitive way to assess human health risk," says the US's Formaldehyde Institute.

The most virulent opponents of formaldehyde have to concede that there is no epidemiological evidence to link the chemical with human cancers. Studies have looked at workers making formaldehyde resins and at professionals, such as embalmers, morticians and pathologists, who all use the chemical regularly.

High rates of brain cancer have been found among some of these professionals, along with some excesses of leukaemia and cancer of the colon. But a review of the evidence in the American journal *Environmental Science and Technology* noted: "All of these professionals work with a number of chemicals in addition to formaldehyde, as well as with human tissue." So the picture remains murky.

Few independent scientists share the faith of the industrialists that, if there is a risk, epidemiologists will find it. Norton Nelson, a former director of the New York University Institute of Environmental Medicine, told a congressional hearing on formaldehyde: "Epidemiological studies must be regarded as a crude and insensitive tool. Only the most violent and intense carcinogens are likely to be detected by epidemiological techniques." In other words, it worked for asbestos and smoking, but it will not necessarily spot any killer potential in formaldehyde.



High concentrations cause injury—will low-level exposure?

The industrialists think that they have the trump card, however. Formaldehyde, it turns out, occurs naturally in the human body as a metabolite. Its concentration in normal tissue is around 3-12 ppm, rather higher than the maximum concentration of 2 ppm allowed in the atmosphere of British factories.

In the course of a sharp exchange of letters in *Science* magazine in May this year, William Havender from Berkeley in California claimed that "this suggests that our bodies are capable of handling it [formaldehyde] safely as long as exposure is not much higher than the amount the body itself manufactures".

Havender cited the famous rat study to bolster his case. The sudden take-off in the number of cancers at high doses of formaldehyde among the North Carolina rats suggests, he said, that the rat's enzyme system can cope with a certain amount of the chemical, but that it becomes "saturated" at higher doses, resulting in a sudden leap in tumours.

But Nicholas Ashford, a scientist from the Center for Policy Alternatives at the Massachusetts Institute of Technology, dismissed this theory. The body may be good at preventing formaldehyde reaching DNA and damaging it to create tumours, but why should we suppose that the defences are perfect? he asked. "Over the course of evolution, it is likely that some rough balance has been struck between the biological costs of formaldehyde's damage and the biological costs of increasing internal defences against formaldehyde, but there is no chance that the damage has been entirely eliminated ... One simply cannot identify 'natural' with 'safe'."

This perhaps takes us full circle. Ashford argued in his letter for a tough line on chemicals that may cause cancer. But if the human body has to balance the cost and benefit of having a toxin floating around the system, then so must human society. The problem is: where should the balance be drawn?

Practically nobody in an industrialised society passes a day without coming into contact with formaldehyde in some form. On the other hand, very few people get nasal cancer. So perhaps we are safe enough. But, if the chemical causes nasal cancer in rats it may cause other different cancers in humans—perhaps cancers that are much more difficult to tie down to a cause.

The case of asbestos, one of the great avoidable killers of recent times, is relevant. The alarm bells rang for asbestos because scientists found that asbestos fibres were the only known cause of a rare cancer of the lung's lining, mesothelioma. This was an unusual instance of certainty on the cancer trail, and it sent scientists into a frenzy of research into asbestos.

As a result we know that far more people are probably killed by asbestos causing ordinary lung cancer, than by the mesothelioma route. Without the discovery of the mesothelioma link, however, it seems likely that asbestos sales would still be booming—and deaths from asbestos-induced lung cancers would still be booming too. □

NCIA

Foam insulation made from urea-formaldehyde was banned in the US in 1982

The West aligns its research

Fresh ideas are changing the nature of scientific collaboration in Europe, and also promoting information exchange among a new grouping of the seven "summit" nations. The groundwork for these schemes is already showing up gaps in national programmes

Ros Herman

Leaders of the summit nations meet at Versailles in 1982

IN PRINCIPLE, science knows no borders and no nationality: nevertheless today scientific research cannot survive without sponsorship by individual states, with the concomitant expectation of a national return. Yet political forces are turning the wheel full circle. Some types of science are now just too expensive to pursue nationally, and some form of collaboration among nations is a must if small countries are to continue their involvement with subjects such as particle physics or thermonuclear fusion.

But there is another important thrust towards collaboration : a growing perception of the need for a geographical or political grouping of nations to maintain its supremacy relative to another grouping by ensuring the best possible use of its intellectual and financial resources. Over the last 20 years or so this second motivation has gradually taken over from expense as a driving force for collaboration, particularly as public and governmental expectations of the economic, social and, indeed, military fruits of science have grown.

This trend is particularly clear in the changing approach of the European Communities (EC) to collaboration in science and technology. Twenty years ago, atomic energy was the only topic thought worthy of major investment, with small efforts in agriculture and coal and steel technology. At that time Britain and Scandinavia were largely going it alone. While the collaboration in building the European Nuclear Research Centre (CERN) at Geneva, for pure research into particle physics progressed quickly, similar efforts for collaboration in astronomy and molecular biology did not get off the ground until the late 1970s. Even then, the Communities (by this time with Britain and some Scandinavian countries on board) took little interest, except in research to safeguard energy supplies.

Over the last five years or so all this has changed. The basic reason is simple. The EC has—albeit slowly and painstakingly—developed a world view in which science and technology are to play a vital part in a "second Renaissance" for Europe. The Eurocrats have in the past come out with some hard words about the stagnation of science in Europe, the diminishing opportunities for mobility and exchange within the Community, and the poor take-up of scientific results by industries that could profit by them. By almost any yardstick, the Europe of the 10 compares unfavourably in these endeavours with Japan and the US.

As far as its own investments are concerned, the Commission of the European Communities, to be specific DG XII for Science Technology and Development, has altered its strategy in three major ways. The leading light behind the new philosophy is ebullient, energetic Italian Paolo Fasella, an Italian biochemist who is DG XII's director general. Fasella has been instrumental in initiating major programmes to encourage research, training and information-gathering. So far as possible these will not involve the setting up of new centres, but rather provide resources for collaboration between existing groups in goverment laboratories, academia and industry. The emphasis is on doing what is not already being done nationally, and particularly in looking at the ways national and community policies dovetail with future prospects.

The first example of this new approach is the ESPRIT programme in information technology. After a pilot phase of 38 projects a further 90 are due to be announced any day now. Allowing for completed projects, this will make a total of 119 under way in 1985 at a cost of ECU 200 million (£120 million). Industrial participants will match the EC component in each case.

Plans are already in hand for a similar effort in biotechnology. Research and training will, once again, take the lion's share: ECU 106 million out of the total of 200 million for the period July 1984-June 1989. There will be pre-competitive projects in basic genetic and biochemical methods, and understanding and exploitation of appropriate organisms, tissues, cultural cells, genes and gene products. Databanks and collections of tissues and materials will be set up. Already the EC contributes to a data bank on nucleic acids at the European Molecular Biology Laboratory at Heidelberg. There will be specific projects to fill the gaps likely to be left by industry in developing products and health care provision. Vegetable oil, for example is one product that Europe is short of: perhaps the sponsorship could help to identify suitable crops and possibly take the idea through to a "demonstration project". Eventually, the EC will back demonstration projects designed to ease the transition between research developments and full-scale exploitation.

The EC will also attempt to keep a watching brief on work relevant to biotechnology throughout the community, and monitor national regulations relevant to research, testing and product design. Intellectual property rights in biotechnology will be another subject of study.

In some ways, Fasella acknowledges, community policies, including the Common Agricultural Policy, could hold back biotechnology—some raw materials such as sugar and starch for industrial use are more expensive than on world markets, and this will undercut the competitiveness of EC producers. For example, citric acid is cheaper to produce outside the EC and there is no tariff on importing it into the Community. Not surprisingly, citric acid plants in the EC countries have closed in recent years. Similarly cheaply produced penicillin is imported from Spain. And multinationals will obviously choose to make such products outside the community if they can.

For the first time the commission as a whole has now initiated discussions on how to alter its own rules to help its chemical industries avoid these penalties. The commission's directorates concerned with industry, agriculture and research are now hard at work at reconciling the pricing of farm products with the economics of the biotech industries.

Also, biotech could come up with ways of turning the EEC's famous food surpluses into more marketable products. In the long term such research could come up with better ideas for using the land that is producing the surpluses; plant cell biologists could, for example, develop new products based on wood lignin, making it worthwhile to replant farmland with forests.

Beyond the glamour of IT and biotech lie the well established industries based on traditional technologies. In some member countries, government research labs have been beavering away at the science behind technologies such as welding, corrosion and catalysis for years, coming up with answers that sometimes do not match the questions their local industries are asking. Their results may, however, be very useful to a company in another community country. The aim of the EC basic research in industrial technology (BRITE) programme is to help such potential partners find each other and then support projects that will bridge the gap between the more academic approach and data that is of immediate interest to a particular company. This will take 170 million ECU (£102 million) over the next five years.

Perhaps the most innovative addition to the EEC's programme for the late 1980s is a rather small-scale plan to help reinforce basic research in Europe. The first part of the plan will provide research grants for projects that fall between cracks geographically and in terms of disciplines. The ideal candidate for this scheme is of high scientific quality and originality, involves researchers from more than one community country, crosses borders between scientific disciplines, and has both basic and applied aspects. A committee of top-rank scientists from all over Europe will allocate money (135 million ECU [£81 million] in the first two years, 1985-86) for travel, secondment, training and laboratory tuning for successful projects. Priority subjects include mathematics and information technology, advanced optics, surface chemistry and physics, chemistry, biocommunication, earth sciences, oceanography and scientific instrumentation. DG XII hopes to involve 4000 researchers, 1 per cent of the European total, by 1988.

The second phase of this plan could include another element: providing funds for contracts with large expensive laboratories that provide unique opportunities for researchers. Already many large laboratories are on the lookout for collaborations with teams from other countries, preferably including an element of funding to contribute to running costs or building new equipment. Some new schemes may only be able to go ahead with multilateral support: the European Synchrotron Radiation Facility, which has been under discussion by the European Science Foundation for nearly a decade now, is one of these. Small countries find it difficult to gain access to these laboratories because the entry fee is too high to justify the use their researchers would make of them. DG XII plans to take out contracts on behalf of consortia of small countries. As well as giving scientists freer access, it would help the laboratories to plan ahead by guaranteeing relatively large chunks of income.

The new schemes will all be up for discussion at the Council of Ministers meeting on 6 November. Of the programmes in the package, the stimulation of basic research may be top of the list for final approval then.

With all this Euroconsciousness it is sometimes easy to forget that the Western world as a whole has common interests. Recently, the voice of the West (once embodied by the Organisation for Economic Cooperation and Development) has found a sharper outlet in the annual Summit conferences of its seven leading nations the US, Japan, Canada, West Germany, Britain, Italy, and France. At the Versailles conferences in 1982, at the suggestion of President Mitterrand of France, the summit set up a working group on Technology, Growth and Employment (TGE). Over the next year the group, which consists of senior science and technology advisers in the summit countries, developed some ideas about how they could work together to promote technological innovation and thus stimulate economic growth.

In the event, it took until the June 1984 London Summit to publish a report. This encapsulated the notion that "the necessary impetus to rejuvenate industry, promote trade and develop human welfare must come primarily from the introduction of new technologies." A summary issued by the Cabinet Office in London clarified the report's view of the importance of science and technology in innovation, identifying three major issues.

The first of these was the importance for economic growth of international cooperation in science and technology, which sustains innovation and facilitates early agreement on standards for high technology products.

A joint effort to pool knowledge and expertise on environmental protection was the second point; the last concerned preparation through education and training for the impact of technological change on society. Down in the fine print the careful reader can also find another objective: effective cost sharing in the construction of major new facilities.

The Versailles programme materialises

By 1984 the Working Group also had more concrete progress to report. It had identified 18 areas where collaboration might be useful, picked lead countries for each from among the seven, and added to those countries who would participate and observe. In some cases, international technical organisations were involved too. Each of the groups also has a set of practical aims and objectives.

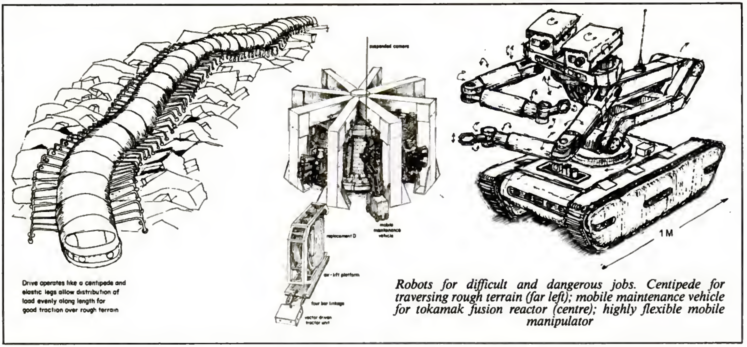
Some of the programmes have come up with surprisingly constructive results. In the area of advanced robotics, for example, France and Japan are the leading countries, with Canada, Germany, Italy, Britain and the US as participants. The Commission of the European Communities, (which is now represented at the Summit as a full member) is an observer, along with Austria. Already the group has parcelled up the advanced robotics business into subdivisions appropriate for collaborative research, again with "initiative" and "member" countries. Germany and the USA will concentrate on robots for civil engineering, for example; Italy will lead off in space and France and Britain with mining robots.

Preliminary plans for British participation in this project have already highlighted weaknesses in the research programme in robots for dangerous environments such as mining and handling radioactive materials, both inside nuclear reactors and during disposal of wastes. Both of these tasks use very similar technologies. The Robot Laboratory at Warwick University's Department of Computer Science is one of the leading British groups in this field.

According to Dr Jim Halsall, one of the senior researchers at Warwick, Britain had a head start in this area but recently, funding from the public agencies has dropped dramatically. For example, the robotics initiative of the Science and Engineering Research Council now concentrates on robotics for manufacturing industry, leaving no funds for the more specialised work.

Now other countries, such as the US, have begun to invest heavily: Carnegie-Mellon University at Pittsburgh in Pennsylvania in particular, has launched a big programme on remote handling in the wake of the Three Mile Island disaster. These and other groups look set to overtake the British efforts very soon. The point where Britain will be so behind that it will not be wanted as a partner in the collaboration may not be far away.

It is just possible that the Versailles initiative will prompt government funding agencies such as the Department of


Drive operates like a centipede and elastic legs allow distribution of load evenly along length for good traction over rough terrain
suspended camera
replacement D
mobile maintenance vehicle
air-lift platform
four bar linkage
vector driven tractor unit
1 M

Robots for difficult and dangerous jobs. Centipede for traversing rough terrain (far left); mobile maintenance vehicle for tokamak fusion reactor (centre); highly flexible mobile manipulator

Trade and Industry to increase the money available. Alternatively, public and private industries may come up with more funds. These include the National Coal Board (which also does its own research along these lines) the Central Electricity Generating Board, and British Nuclear Fuels.

The advanced robotics group as a whole will work on common standards for robot components, interfaces, communications and languages, establish and implement common criteria for evaluation, and exchange information. As with all the TGE collaborations, no new money will automatically be set aside: existing organisations will have to dig into their normal budgets.

Britain and the US are taking the lead in a project on advanced materials and standards. Among the participants, West Germany will take on wear testing, while Britain and the US will work on surface analysis. Here the main focus is to establish codes of practice for advanced engineering materials so that the Western world can agree on standards, and trade barriers that arise because of consistent specifications can then be removed.

Topics to be considered in future include fatigue, corrosion, bioengineering materials, fusion weld penetration, polymer composites, ceramics and cryogenic materials. Britain is the sole lead country in a project on "public acceptance of new technologies". The Department of Trade and Industry has already come up with money for three British groups to work on relevant projects: these will collaborate closely with French and German equivalents.

Inevitably perhaps, biotechnology figures on the list and, again, Britain is a lead country (with France). All the summit countries (except the US) will take part. So far the working group has distributed a brochure on biotechnology courses in Europe designed for students from developing countries and the first group of students thus recruited will start in 1985.

Dr Ronald Coleman, Government Chemist, is the British member of the biotechnology working group. He has been most concerned with one of the topics identified as a good candidate for collaborative research: "downstream processing" of the products of fermentation: in other words, how to turn them into useful products. He says that the success of the programme depends on convincing potential participants at an early stage that pooling information will be profitable for everyone. "You've got to get people who are roughly equal", he says. And, he thinks, if the participants identify with the aims of the project it will be possible to save money by avoiding unnecessary duplication.

Interestingly enough, basic science figures in the collaborations too: a basic biology programme, led by the EC, will aim to "intensify international cooperation: in order to improve efficiency of efforts." The group aims to establish working agreements between American, European and Japanese biological information centres within a year. The US is leading a group on high energy physics, which hopes to collaborate on developing the necessary technologies and materials for new detectors and accelerators.

These examples illustrate some basic principles of the scheme. Dr Robin Nicholson, chief scientist to the British Cabinet Office, has just completed a year as chairman of the main Technology Growth and Employment working group (corresponding to Britain's year as hosts). He points out that the object of the exercise is not to try and muscle in on collaborations that already work, rather the groups will look for entirely new ideas, or pick up on subjects where existing collaboartions were not proceeding fast enough.

The EC and Summit initiatives for technical collaboration offer interesting contrasts of approach and style. Within the EC a fairly strong motive is to promote technical development in smaller and more backward countries to bring them up to the level of the most prosperous. The summit countries are more sanguine: according to Nicholson, their groupings are designed to work at the most advanced possible levels, and determined to avoid large committees because they tend to take much longer to reach agreement and get on with the job. For the EC, as Fasella points out, the idea will be to help Europe compete economically and technologically with the other major Western groupings: the US and Japan (although recent news that American firms are to be allowed to participate in ESPRIT fits in rather strangely with this philosophy).

To what extent collaboration among the summit nations will help Europe, or indeed the other participants—all potential cut-throat competitors—is not exactly clear. But the TGE working group's report mentions two relevant factors. One, already noted above, is to break down barriers to trade between Western nations imposed on either commercial or technical grounds. The other adds a slightly sinister note: the need to keep the West's high tech products out of the hands of the East, while maintaining information exchange and trade throughout the West. These efforts seem to be very much in our interests. But could it possibly happen that 1984 is the year that George Orwell's vision of a small number of large political and economic world groupings came one step nearer reality, this time drawing in scientists and technologists that much more explicitly? □

Beryl's just wild about flowers

Which could explain why, this past summer, Mobil's massive 500,000 tonne 204 metre tall platform was sporting a sunflower on her crown.

This bit of horticultural frippery wasn't merely the handiwork of homesick roustabouts trying to recreate their gardens 95 miles southeast of Shetland.

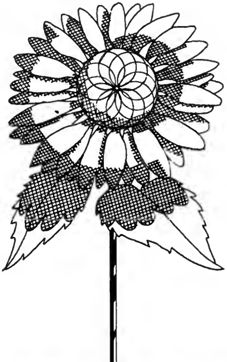
There was a much more noble motive behind the care lavished on Beryl's cherished *genus helianthus*.

The exercise was part of a North Sea-wide charitable drive: a sponsored sunflower-growing competition with cash donated to the Royal Scottish Society for the Prevention of Cruelty to Children in proportion to inches of floral growth. In the Beryl field, the competition was run by the first and only charitable foundation in the North Sea.

Composed entirely of those who work on or in support of the Beryl sister platforms, the foundation has already made a substantial impact on the Aberdeen area and beyond. Among the beneficiaries of its largesse have been local hospitals, the handicapped, and children's homes. Sunflowers aside, funds have been raised through sponsored runs, cycle marathons, and even a chicken-eating contest.

Making money is the primary business of every offshore platform. But on Beryl A and her newly-operational sister, Beryl B, *raising* money for worthy causes has taken a healthy second place in platform priorities.

Beryl may sport a jaunty flower on her crown. But she wears her heart on her sleeve.



Mobil Beryl B

Mobil North Sea Limited

Food additives: a technology out of control?

In a year we consume several kilograms of preservatives, colourings and flavourings. Yet we know little about what effects these chemicals may have on us

Erik Millstone

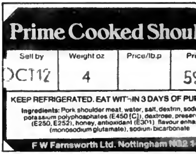
IN THE past decade we have witnessed an enormous growth of interest in the possible risks to human health of chemicals in our industrial environment. Yet in Britain few scientists outside the closed worlds of government and industry have scrutinised the use of additives in food. In the US, France and Scandinavia, for example, far more public and professional attention has been paid to food additives, and these countries have far stricter regulations than prevail in Britain. Industrial chemistry has provided food technologists with a powerful array of tools with which to create their products, but we know surprisingly little about the effects of this "new food" on human health.

Food additives are chemicals that are introduced by industrial manufacturers into food products to alter the foods in ways that make them more marketable. One important group of additives is the preservatives, chemicals that slow down the rate at which foods deteriorate. They are particularly important in many processed meat, fish and cheese products. In Britain, food distribution and retailing is highly concentrated so that as few as 45 major distribution centres handle some 80 per cent of all the food marketed. Hence the ability of preservatives to give food products a long "shelf-life" is of enormous economic value to the food industry, and is of some nutritional value to consumers. Other types of additives are at least as valuable to the industry, but of less obvious nutritional value to consumers. These additives include colourings and flavourings that play a cosmetic role in disguising the real qualities of food. Some food products just could not exist without additives. Ham, for instance, would be just salt pork without sodium nitrite. Many soft drinks are simply water plus sweeteners, flavourings, colourings and preservatives.

Last year, to a first approximation, British food and drink manufacturers spent between £160 million and £180 million on food additives out of a turnover of some £6000 million, that is, between 2 and 3 per cent of their turnover. The economic benefit to the industry has yet to be computed, but nobody denies that it is much cheaper to make pizza with synthetic cheese and tomatoes than it would be with real cheese and tomatoes. However, although highly processed foods containing food additives may provide a low cost per portion, they may have a higher cost per unit of nutritional value, because many synthetic substitutes have little or no nutritional value in comparison with the ingredients they replace.

Nobody knows how many additives are used in Britain, nor do we know, in general, the quantities consumed. The educated guess is that on average each member of the British population may consume anything from 3 to 7 kilograms of additives per year, but because some people eat so few, others may be eating up to 10 or 15 kg each year. At the last count, the government was regulating the use of only some 314 food additives, and approximately 148 of these were also being regulated by the EEC. The regulated additives, however, almost certainly constitute less than 10 per cent of the total number in widespread use—probably more than 3500. Food flavourings alone account for some 3000 of these, but flavourings, along with starches and enzymes, are not specifically regulated, and so their use is barely monitored. The details and extent of the use of flavourings are considered to be commercial secrets both by governments and the firms using them. A relatively straightforward raspberry flavour for an emulsified product that has to endure high temperatures in processing in a highly acidic product may contain seven or more distinct flavouring chemicals. Each company knows which flavourings it is using, but nobody knows what the industry as a whole is doing.

When the food industry seeks to defend its use of additives it does so primarily by reference to three considerations. By using additives the industry can expand the range of products available to consumers particularly in cities; it can extend the life of the product on the shelves of a warehouse, shop, fridge or larder; and it can make products appear and taste more attractive than they otherwise would.



Prime Cooked Shoul

Sell by	Weight oz	Price/lb.p	Pr
OCT12	4		59

KEEP REFRIGERATED. EAT WITHIN 3 DAYS OF PU

Ingredients: Pork shoulder meat, water, salt, dextrin, sod
potassium polyphosphates (E450 [C]), dextrose, preser
(E250, E252), honey, antioxidant (E301) flavour enha
(monosodium glutamate), sodium bicarbonate

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These arguments are not, however, entirely convincing. The weakest argument is the supposed needs of urban life. Given the commercial organisation of food distribution it is in fact far easier to obtain a wide range of fresh foods in city centres than in remote rural areas. Preservatives do extend the shelf lives of processed foods, but, worryingly, because they accumulate in our flesh, they also appear to extend the shelf lives of human corpses on the shelves of undertakers. More importantly, the shelf-life argument applies only to preservatives, anti-oxidants and anti-fungal agents, which together account for less than 1 per cent by value and a few per cent by weight of additives used. Certainly, cosmetic additives may enable materials to appear and taste more attractive, and this may reduce wastage, but it may also permit manufacturers to use inferior materials and poorer processing techniques and to sell the result at higher prices than they would otherwise command.

Testing additives for toxicity

Apart from the fact that they may mislead consumers about the true character of their food, great care must also be taken to ensure that additives have no toxic effects when used in food products. We can assume that professional toxicologists are as responsible a body as any other group of scientists, but we may still have serious doubts about the ability of toxicological techniques to provide us with reliable information about the toxicity of food additives. First, while consumers know practically nothing about the potential toxicity of food additives, they are encouraged to believe that vigilance by science, industry and government ensures the safety of our food supply. However, the government permits the use of those additives which it regulates by reference to information provided by the industry and in secret. All the deliberations of the Food Advisory Committee (until recently the Food Additives and Contaminants and the Food Standards Committees) of the Ministry of Agriculture, Fisheries and Food (MAFF), as well as all the technical data on which it gives its advice to ministers, are covered by the Official Secrets Act. The government defends this practice by pointing to the commercial interests of the companies, but without reference to the interests of consumers.

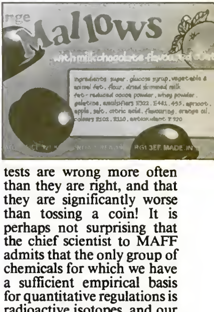
In addition there is a general problem about the methods used by scientists to determine toxicity. Food additive

Photographs by Pete Addis

Most of the products of the modern food industry contain additives of one sort or another

toxicology relies on three sets of data to determine what is and is not safe. First, one can look to human epidemiology, but in relation to food additives this science is about almost entirely useless. Tobacco smoking kills about 25 per cent of its lifetime users, yet it took about 25 years for epidemiologists to demonstrate this fact. With some 3500 or more additives used in some thousands of products and in millions of combinations, in small quantities (although in some cases using up to 30 different additives in a single product), and it is impossible for epidemiology to identify any long-term or chronic effects of the use of particular food additives. In recent years a range of *in vitro* tissue culture tests has been devised. These so-called short-term tests can identify some mutagenic effects in test organisms, but at most these tests will detect a subset of a subset of cancer-causing chemicals: they are irrelevant to all other toxic hazards.

The regulation of food additives is based almost entirely on animal tests. Only recently has there been any attempt to establish a quantitative estimate of the correlation between toxicity tests with laboratory animals and human toxicology for chemicals that are believed to cause cancer. This analysis, carried out by David Salsburg of Pfizer Central Research in the US, suggests that the animal tests are successful in identifying carcinogens only some 37 per cent of the time. This means that the results of the tests are wrong more often than they are right, and that they are significantly worse than tossing a coin! It is perhaps not surprising that the chief scientist to MAFF admits that the only group of chemicals for which we have a sufficient empirical basis for quantitative regulations is radioactive isotopes, and our knowledge of this field is only as extensive as it is because of our experience with the use of nuclear weapons. Yet regulations are determined by extrapolation from the results of animal tests. On account of possible differences between animals and humans and on account of differences within human populations, a safety factor of 100 is usually introduced between the no-effect-level in animals and the acceptable daily intake for humans (calculated in milligrams per kilogram body weight). There is, however, wide-ranging disagreement on how to extrapolate from the results of tests on small groups of animals to large groups of human beings who do not live in laboratory conditions. There are at least 12 different competing statistical techniques for this extrapolation, and the results which they produce may disagree by up to four orders of magnitude. In other words, the uncertainty is approximately the square of the supposed margin of safety.


Mallows
ingredients sugar. glucose syrup. vegetable & animal fat. flour. dried skimmed milk fat-reduced cocoa powder. whey powder. gelatine. emulsifiers E322. E481. 435. apricot. apple. salt. citric acid. flavouring. orange oil. colours E102. E110. antioxidant E320
RG1 3EF. MADE IN

Despite the uncertainty over their effects on human health, the use of food additives has grown rapidly since the Second

Can food additives damage your health?

MOST of us consume additives in our food with impunity, but evidence is growing that a few people are not so lucky. Allergic reactions, as well as hyperactivity in children, have been linked to particular colourings, preservatives and antioxidants.

Tartrazine (E102), for instance, a yellow dye added to a variety of foods and medicines, may provoke asthmatic attacks and skin rashes, especially in people who are sensitive to aspirin. Sulphite preservatives can also cause rashes and abdominal pain, according to Dr Alice Huang of Harvard Medical School. In studies carried out by Dr David Atherton at the Hospital for Sick Children, Great Ormond Street, in London, some children suffering from eczema improved when colourings and preservatives were excluded from their diet. His colleague, Dr John Egger, found that artificial colourings provoked severe migranes in some children suffering from the complaint.

These and similar studies give cause for concern; but it is difficult to assess how many people are affected by food additives. A joint report of the Royal College of Physicians and the British Nutrition Foundation estimates that perhaps some 0·15 per cent of the population is at risk.

Research into the links between food additives and behavioural disorders in children is more extensive. In the early 1970s, Dr Ben Feingold, an American clinician specialising in allergy, claimed that artificial colours and flavourings in food, as well as naturally occurring salicytes (in some fruits, for instance) could lead to hyperactivity and learning disabilities in children. He estimated that 50 per cent of hyperactive children could be completely cured by a diet that eliminated these chemicals. Attempts to substantiate his clinical experience in double-blind trials have yielded inconsistent results. But it seems that at least a small number of hyperactive children do benefit from his special diet.

Food additives may also be carcinogenic, but again we know little about whether the low levels present in some foods present a real hazard to humans. Two artificial sweeteners, saccharin and cyclamate, along with nitrites used to cure meat, have attracted most attention. Large doses of saccharin, comprising a few per cent of the diet, causes cancer of the bladder in rats. But there is no sign of any increase in bladder cancer in humans that could be attributed to the introduction of saccharin; and diabetics, who tend to consume more saccharin than other people, are not especially likely to develop the disease. Another artificial sweetener, cyclamate, was taken off the market in the US in 1970, after animal experiments suggested that it too could cause bladder cancer in rats. But later studies failed to find a consistent link between the sweetener and cancer, and cyclamate may shortly be reintroduced to the American market. Even so, caution is in order. As the Oxford epidemiologists Richard Doll and Richard Peto point out, "human exposure to a weak carcinogen may need to be prolonged for several decades before any positive effect can be detected, and no assurance can be given that an effect will not be produced by a lifetime of exposure to the unusually large amounts that are consumed in diet drinks by some children and young adults".

Nitrites and nitrates, used to preserve meats since the last century, are also a possible source of human cancer, especially of the liver. These compounds can be transformed in the gut to nitrosamines, which are powerful carcinogens, so supplementing the low levels of nitrosamines already present in some meats. Although nitrite added to food probably consitutes only some 10 per cent of the nitrites we ingest in vegetables and saliva, the additive may be disproportionately important, Doll and Peto suggest, because it arrives in the stomach in concentrated packets. Nitrites are also added to some cheeses, such as Samsoe and Emmenthal, and many processed cheeses.

Sulphur dioxide and the related sulphites are versatile preservatives that maintain the pale colour of everything from sultanas and sausages to flour and beer; they also inhibit the growth of microorganisms. One disadvantage of sulphur dioxide is that it destroys the vitamin thiamine (B_1) in food. Sulphur dioxide also induces mutations in bacteria. It may not present a similar threat to people, because our liver and kidneys possess an enzyme, sulphite oxidase, that converts sulphite to sulphate, which is then excreted. But it is conceivable that this detoxification process could be overloaded by a diet composed largely of processed food, beer, wine and cider.

Finally, some additives are suspected of being potentially damaging to the fetus or infants and so are not permitted in baby foods. In large doses, monosodium glutamate (MSG), a flavour enhancer, causes severe brain damage in young animals. It became notorious some 12 years ago as the cause of "Chinese Restaurant Syndrome"—headaches, dizziness and burning sensations experienced by some after eating a Chinese meal heavily laced with MSG. The antioxidants butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) have also been shown to induce abnormal growth and behaviour when fed to mice before weaning. But the relevance of these animal studies to the human situation remains an open question.

Gail Vines

World War, doubling over the past decade alone. To appreciate why this is happening we need to understand something about the dynamics of the market for food. The market for food is in some ways quite special because, in the jargon of economics, the demand for food is notoriously price inelastic. If the price of records were halved many of us would buy twice as many albums, but if the price of potatoes were halved few of us would eat twice as many potatoes. This is significant because there are technological and political reasons why the relative and absolute prices for foods have been declining.

Despite the expectations of Malthus and the Malthusians, the effect of technological changes in agriculture over the past 200 years has been to raise the productivity of labour in farming more rapidly than population growth, and more rapidly than in almost any other productive sector. But the farming lobby has been politically successful throughout the Western world in persuading governments to subsidise agriculture so as to keep marginal farmers in production. Thus the problem for the food industries of the industrialised countries is not one of scarcity, but of a surplus of cheap products. This has provided an opportunity for, rather than a threat to, the food processing industry, which generates profits by taking cheap and plentiful foods and synthetic ingredients and transforming them into "value-added" and so higher priced and more profitable food products. Take the example of potatoes and their transformation into crisps. Last autumn, at the height of the potato-cropping season the chip manufacturers could buy a tonne of potatoes for £70 to £94. From one tonne of raw potatoes one can manufacture approximately a quarter tonne of crisps. When we buy a standard 25 gram packet of crisps we are buying one penny's worth of potato solids which have been processed into a cooked, preserved, flavoured, packaged, advertised and delivered potato product for 12p. The production and sale of crisps, and similar products, reduces or eliminates potential or actual surpluses of fresh foods and expands the total value of the market for foods. Additives are invaluable for the food industry in this project. Antioxidants prevent the oil in which crisps have been fried from turning rancid, and flavourings can create the illusion that bacon, beef, prawns or even hedgehogs have contributed to their final flavour. It is, of course, cheaper to create the illusion that prawns have been used than to use real prawns.

Industry argues that it is are merely providing what consumers want, and of course it is true that the industry cannot sell what people refuse to buy. But there is genuine consumer sovereignty if and only if consumers have adequate information and choice, and we have plenty of reasons for doubting that these conditions are currently being met. The limitations of contemporary toxicology which have already been described entail that not even the industry or the government has adequate information, but it is clear that consumers have vastly less information than do either of those two groups. The access which consumers have to information about the composition of foods and the toxicology of additives is far too slight for any real consumer sovereignty to obtain. I have been studying the food industry for several years from the relative privilege of a university and I have had great difficulty in discovering the identity of all the additives in use in food products on the British market. It is now possible to obtain from MAFF a document entitled "Look At The Label" which lists the names of some two-thirds of the regulated additives, and the numbers which can be used on labels to indicate their presence in a product. (Numbers prefaced by an "E" indicate an EEC-wide identification.) It is possible, but difficult, to obtain from MAFF a list of those additives which are regulated, but which do not yet have a number. It is entirely impossible to obtain any list of all the unregulated additives which are in use. Even if consumers knew what the foods contained however, this would tell them little or nothing about their safety. All toxicological data is published if at all only in technical journals and books, and no efforts have been made to open up this field to public scrutiny or accountability.

A science, or a technology?

Research on the toxicology of food additives is almost entirely confined to industrial research laboratories, or to the laboratories of industrial organisations such as the British Industrial Biological Research Association (BIBRA). The government does not conduct safety evaluations on particular additives, nor does it commission independent research. (This is just one of several respects in which the US and other EEC countries are ahead of us.) As a result, in Britain, as the director of BIBRA has himself pointed out, food additive toxicology is not a science which seeks to understand the biological effects of chemicals upon humans, but merely a technology designed to produce animal test data sufficient to gain permission from governments for the use of additives.

Last summer a chemistry student at my university tried to establish how much information consumers had about food additives, and how much they thought they had. In a pilot study she discovered that 60 per cent of shoppers thought that they had adequate information, but fewer than 20 per cent had ever heard of the E-numbering system. Consumers have to rely solely upon the information provided on labels, but even when there is a label and a declaration this can be unsatisfactory. Consider the contrast between the meaning of the two apparently similar terms "flavoured" and "flavour". A product which is labelled as "bacon flavoured" must derive its flavour entirely or primarily from bacon; a "bacon flavour" product need contain no bacon whatsoever, but must merely resemble the relevant flavour. Given that most people are unaware of this semantic subtlety, this labelling device is systematically misleading.

Consumers cannot even take it for granted that all additives in a product appear on the ingredient declaration on the label, as there are a whole host of "exceptions" to the labelling regulations. Without an encyclopedic knowledge of the regulations, we cannot know what we, or our children, are eating and drinking. Industry has fought a sustained campaign against the current labelling regulations. The exceptions were introduced at the behest of the industry, not because consumers insisted that they did not want to know. Furthermore, industry argues that if consumers were to receive far more information they would not know what to do with it. Certainly, if you keep people in the dark for their lives and then suddenly bombard them with information they will initially be disorientated. But surely this calls for a sustained programme of health and nutrition education, rather than for continuing secrecy and misinformation.

If consumers are to be sovereign in the marketplace then they require sufficient choice as well as adequate information. Food manufacturing is a highly concentrated industry, and

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THE MASTER'S PROGRAMME

New additives through genetic engineering

ENZYMES are commercially among the fastest-growing group of food additives. They are a class of proteins which, as biological catalysts, control metabolic reactions in living organisms. Their role in digestion has provided the basis for their many applications in the food industry. Yet in Britain there are moves afoot to control more closely the use of these seemingly innocuous substances in foods which have thrown the food industry into a flurry.

At a rough estimate more than 50 enzymes are used in the food industry: in brewing, cheesemaking, the production of fruit juices and wines, starch and sugar processing and as meat tenderisers. Three enzymes, for instance, form the basis for an industry manufacturing liquid sweeteners from cornstarch. Such sweeteners are widely used in soft drinks and confectionary. The current market for industrial enzymes, including those used in food, is around £200 million and expected to grow to between £500 and £600 million by the mid-1980s.

Europe dominates the world in sales, with Novo Industrie in Denmark and Gist Brocades NV in the Netherlands controlling 60 per cent of the world market. Britain's industry remains small, with John and E. Sturges Ltd the main producer. One of the major goals of the government's policy on biotechnology is to boost the production of home-grown enzymes; but the industry says this development may not happen if regulations are tightened.

Traditionally, enzymes have been extracted from plants and animals. Rennin, for instance, the enzyme used to curdle milk to make cheese, is extracted from the stomach of unweaned calves. But the production of enzymes from bacteria, yeasts and fungi is rapidly becoming more common. An American company, Collaborative Research Inc, was recently granted a British patent for its version of rennin, produced through genetic engineering.

The FAO/WHO Expert Committee on Food Additives identified certain hazards associated with the burgeoning and uncontrolled use of food enzymes. It argued that these enzymes could contain potentially harmful contaminants and by-products because the commercial processes for preparing these enzymes, usually kept a closely guarded secret, varies greatly. Mutations in microorganisms could lead to the emergence of new "potentially toxic products" which could go undetected. Other authorities in Britain, for instance, fear that workers exposed during manufacture to even a deactivated enzyme might develop allergies.

Consequently, the FAO/WHO Expert Committee deemed that chemical and microbiological specifications, and the biological control of strains of microorganisms used to produce these microbes, were essential.

The committee also laid down guidelines for dealing with enzymes. Enzymes from microorganisms traditionally accepted as consituents of food required only careful specification. However, enzymes derived from less well-known microbes (including those produced by genetic engineering) require extensive toxicological testing, including animal studies.

In Britain, a report published in 1982 by the Food Additives and Contaminants Committee of the Ministry of Agriculture Fisheries and Food went further. The committee is proposing legislation that will require that all enzymes be put on a 90-day study in rats and a biological screening test (as yet not developed) for the presence of toxins. It remains "unconvinced" by the industry's claims that it makes enzymes only from strains that do not produce toxins. "Neither do we accept the claim that natural occurrence of the source organism in food is necessarily sufficient evidence of safety." Well-known microbes might still produce toxins that current tests cannot detect. Mutation poses additional risks. But the industry argues that it now takes seven years to get a new enzyme to market, and the marginal profits in the food industry could discourage much expensive research.

The potential of such research, especially genetic engineering, is easily seen. For example, pullulanase is an enzyme that degrades pullulan, a polysaccharide, to the maltose syrups that give jams and jellies improved colour and brilliance. They reduce the discoloration of sweets during processing.

This enzyme also degrades another carbohydrate, amylopectin, to produce high amylose starches used in the industry as quick-setting, structurally stable gels, as binders for strong transparent films and as coatings. Their acetate derivatives are added to textile finishes, sizing adhesives and binders. In food, amylose starches thicken and give texture to sweets and sauces, reduce fat and grease in fried foods, and stabilise the protein nutrients, colours and flavours in reconstituted food products such as meat analogues.

A recent report from the Office of Technology Assessment in the US, dealing with the impact of applied genetics, comments that "in view of shortages of petroleum-derived plastics and the need for a biodegradable replacement, amylose's ability to form plastic-like wraps may provide its largest industrial market, although that has yet to be developed". It points out that pullulanase may never fulfil its potential without genetic engineering, because the food industry is permitted to use only enzymes that are obtained from sources "approved for food use" and the chief source of pullulanase is a pathogenic bacterium, *Klebsiella aerogenes*.

However, with genetic engineering the gene for this enzyme could be transferred to another, harmless bacterium such as *Escherichia coli*, which could then be grown up cheaply to provide large quantities of the enzyme. Whether legislation aimed at protecting the consumer in Britain will hamper the development of such products remains a hotly debated question. **Stephanie Yanchinski**

food retailing is a sector with a particularly high concentration of ownership. In 1950 the multiple stores including the Co-ops had together 43 per cent of the the retail food market, but by 1980 they together controlled 75 per cent of retail food sales, even though the Co-ops' share declined from 23 to 14 per cent. Given these conditions of concentration manufacturers and retailers compete, in part, through what is called "product differentiation". For example, several branded ranges of mayonnaise products with added garlic, or whatever have recently been advertised on television. There is a case for saying that consumers are being given the illusion that there is ever-increasing choice, while in practice much of this supposed burgeoning choice is the result of trivial product differentiation. One important option, that of additive-free food, is no longer generally available. It is, for example, almost impossible to buy sausages free of sodium nitrite.

All these considerations indicate that there is a need for substantial changes in the operation and regulation of food markets. If consumers are to gain a more adequate appreciation of the composition and nutritional value of the foods that they eat then governments must take a far more active and constructive role in nutritional research and health education. Currently, the annual advertising budget of one major international company specialising in dairy-based food products is greater than the total annual budget of the World Health Organisation. Information about food is primarily in the hands of private corporations, and minimally in the hands of governments, and substantially unavailable to consumers. If consumers are to attain proper access to information the government has first to obtain it, and then share it with consumers. We need research programmes in the use of food additives, their toxicology, human epidemiology, food processing and market research.

The interests of the consumer require a policy of complete disclosure of toxicological data, the regulation of additives, and the composition of food products. Some products may now be profitable only because consumers do not know what they contain. For consumers do tend to modify their actions when they acquire relevant information. The consumption of tobacco, for instance, is declining among all groups, with perhaps the sad exception of working women. But change will come about only when organised consumer groups exert sufficient social pressure to influence the makers of policy. It is unlikely that consumers can initiate reforms purely through the pressure of the market place. ☐

Dr Erik Millstone is a lecturer in Science Studies at the University of Sussex.

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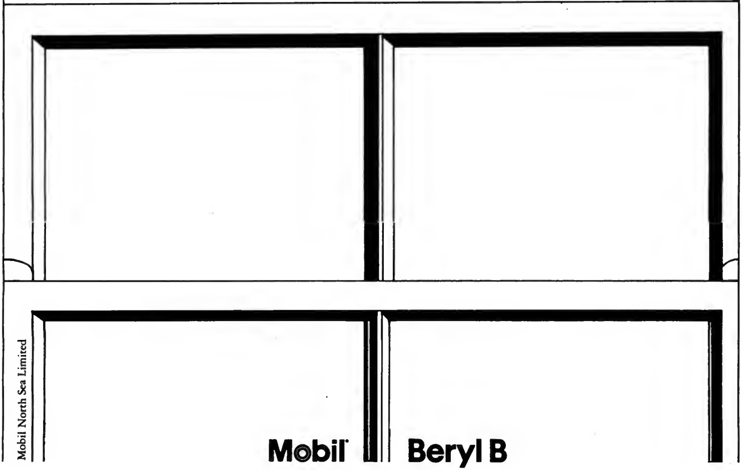

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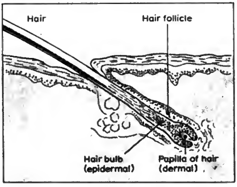
MONITOR

Clues to baldness from a rat's whisker

A NEW treatment for baldness may one day emerge from detailed studies of specialised sensory hairs—the whiskers of a rat. Biologists at the University of Dundee have found a way of stimulating hair to grow from unproductive follicles in a rat's snout (*Nature*, vol 311, p 560).

In humans and other mammals, a "bulb" of epidermal cells at the base of a follicle differentiates into a hair. But another type of cell—a specialised fibroblast known as a dermal papilla—projects into the bulb and controls the production of the hair. In the 1960s and 70s Roy Oliver of the University of Dundee established that the dermal papilla is essential for the initiation and maintenance of hair growth. The new research shows that papilla cells grown in tissue culture, and subcultured up to three times, retain the ability to stimulate the growth of hair. This discovery means that we may eventually be able to activate quiescent follicles or create new ones by implanting papilla cells into the skin.



New hair from implanted papillae?

The Dundee researchers, Colin Jahoda, Kenneth Horne and Roy Oliver, cut away the lower halves of scores of rat follicles to remove their dermal papillae, and then implanted papilla cells that had been grown in tissue culture. In four weeks' time more than half of these mutated and usually subsequently hairless, follicles had produced full-blown whiskers. The follicles that had received the implant developed new bulbs, with epidermal cells properly aligned around the dermal papillae. By labelling the implanted papilla cells with radioactive ^{3}H-thymidine, the researchers confirmed that the functional dermal papillae in the hair-producing bulbs did come from the implants.

Advances in culturing the cellular components of hair follicles are particularly significant because it is extremely difficult to study these tiny structures *in situ*. About two years ago, Dutch researchers showed that epidermal cells taken from follicles could be cultured in the laboratory. Now that the Dundee group has established that cultured papilla cells retain their ability to stimulate the growth of hair, researchers can put the two types of cells together in culture and begin to explore how papilla cells induce epidermal cells to produce hairs, and how hormones such as testosterone influence their interaction. Men with a genetic predisposition for ordinary baldness (male pattern baldness), for instance, do not lose their hair if levels of testosterone drop as a result of testicular disease or castration.

The rat's whisker may thus serve as an ideal biological system in which to study the genesis of hair. But progress is also being made in growing the crucial human cells *in vitro*. Andrew Messenger of the Royal Hallamshire Hospital in Sheffield has managed to culture dermal papilla cells from human hair follicles; he hopes to be able to discover whether a particular form of patchy baldness, known as allopecia areata, is due to a fault in these cells. And the Dutch group, led by Peter Weterings, has managed to culture human follicular epithelial cells which seem to retain some of the distinctive characteristics of hair-producing cells.

We are thus some way from a clinical application of this research. But the prospect of some day growing dermal papillae in cell cultures and then incorporating them either into follicles that have ceased to produce hair, or, more likely, into skin to stimulate the formation of new hair follicles, remains a distinct possibility.

Algal defence

PLANTS go to great lengths to keep animals from eating them, especially their reproductive parts. Not much surprise in that, except that the defence habit extends beyond the sophisticated flowering plants. Chemical deterrents are present in algae, and in one particular kelp a large investment is made to keep herbivores off its own type of reproductive parts.

***Alaria marginaa* is a handsome species of brown alga, spreading up to 3 metres long among the shorelines of the North East Pacific Ocean. Peter Steinberg at the University of California, Santa Cruz offered specimens of the kelp to a hungry little snail, *Tegula funebralis*, which aslso lives on the same shoreline. In laboratory and shoreline experiments he found that more of the vegetative parts of the plant were eaten than the reproductive fronds (sporophylls), which are found near the base of the seaweed. Even when the snails were packed into a high density they still preferred vegetative to reproductive kelp (*Science*, vol 223, p 405).**

The secret of the seaweed lies in its repulsive taste. Phenolic compounds, especially polyphenolics or tannins, deter feeding by the herbivores. But Steinberg found that more phenolics were packed into the sporophylls than the rest of the plant, and that their somewhat tougher consistency helped protect them further. Compared to the elaborate defence measures of terrestrial plants, the kelp's protection is fairly straightforward.

New link between diet and cancer

A MAJOR cause of bowel cancer could be a chemical produced by common gut bacteria. That is the suggestion of a team of microbiologists at Virginia Polytechnic Institute in Blacksburg. Dr Tracy Wilkins and Roger Van Tassell have found the chemical, a mutagen which can damage chromosomes, in the faeces of about 20 per cent of a group of Blacksburg residents. It appears to be related both to the presence of certain bacteria and to high concentrations of bile acids. Bile is released into the gut in response to fat in the diet and diets rich in fat are known to predispose to bowel cancer.

To test the link further, the researchers conducted tests in South Africa. There, the rural black population has a diet high in fibre and low in fat. In the urban white community, diet is more like that in the West; refined and high in fat. Wilkins and her colleagues analysed faeces from both groups for the presence of the mutagen. It was detected in less than 2 per cent of rural blacks but in between 15 per cent and 20 per cent of white residents of Johannesburg.

The presence of the chemical does not mean that it is the cause of colon cancer. Other factors, including a genetic predisposition, seem to be involved. Neither does the fact that it can cause the sort of genetic damage that could trigger cancer incriminate it. Most carcinogens are mutagens, but not all mutagens are carcinogens. The next stage of the work was to identify the chemical. It is known, specifically, as (s)-3-(1,3,5,7,9-dodecapentaenyloxy)-1,2-propanediol or, more pronouncably, a faecapentaene. It was first recognised by Dr W. Bruce at the University of Toronto.

Now, a chemist at Virginia Polytechnic, Dr David Kingston, has managed to synthesise faecapentaene in sufficient quantities to test its cancer-causing potential in animals. The chemical is produced in humans in anaerobic conditions in the lower gut by so-called theta iota omicron bacteria. Two precursors are involved: one unknown, the other from bile. A fatty diet would lead to more bile, but fibre would dilute it and expel it quickly.

Presence of the faecapentaene does not imply cancer. The disease, if it develops at all, may take a decade to manifest. If a large-scale screening programme gets under way, as it has in West Germany, tests for the mutagen may help prepare a shortlist for further investigation. In Britain alone there are 70 000 cases of colon cancer a year, and about half these die from the disease, making it the second commonest cancer after that of lung. If it is spotted early enough, recovery rates after operation are high. President Reagan recently had a gut wall polyp removed by endoscopy. Though benign, such growths can lead to cancer. A chemical test may help to find them sooner. Until it is available, the best advice is still to limit fat intake. Now there is biochemical evidence to support it.

What next for plant interferons?

INTERFERON has quietly slipped out of the public gaze these past couple of years, since its heady days as the "miracle wonder drug" for curing cancer. Disillusionment set in when the results—such as they were—failed to match the inflated expectations. In fact the clinical work still continues, helped by quantities of genetically engineered interferon, with promising results for a host of viral diseases and just a few specific cancers. Meanwhile another twist to the story has emerged, as botanists seriously ask, do plants also have their own interferons?

Consider first the credentials of full-blooded interferons. They are a squad of first-line defender proteins, whose manufacture is triggered by all sorts of virus invaders. They fight these intruders by mobilising the cell's biochemistry and attacking the key components of the rapid growth of viruses—the production of their proteins from RNA templates. Furthermore, the interferons are a tough bunch, and withstand cruel and unusual punishment—extreme *p*H values and relatively high temperatures (over 60° C) have little effect on them.

The thornapple (Datura stramonium)*: the first source of plant interferons*

Hans Reinhard/Bruce Coleman

You can see the possibilities of a plant interferon in many plant viral diseases, where the infection is confined to isolated blotches of leaf tissue, for instance in many cases of tobacco mosaic virus (TMV). The tissue surrounding the blotches develops resistance to the virus, imprisoning the invader in a few hundred cells per infection site. (In some other diseases the resistance movement spreads throughout the entire plant.)

These phenomena prompted a search for a possible virus-fighting plant chemical in the 1960s. G. Loebenstein and A. F. Ross found an "induced interfering agent" in the thornapple (*Datura stramonium*), after extracting juice from uninfected parts of leaves lying next to blotches infected with TMV (*Phytopathology*, vol 53, p 306). When the juice was applied to the infected sites themselves it severely damped the spread of the virus; it was also unusually tolerant of heat and extreme *p*H.

Since then two other interferon candidates have been closely studied. Ilan Sela and colleagues at the Hebrew University, Rehovot, discovered an anti-virus factor in tobacco plants infected with TMV or lucerne mosaic virus. Again, it was a tough protein with many other physical and chemical properties of animal interferons.

When infected tobacco leaves were dosed with human blood interferon the growth of the virus ground to a halt (*Proceedings of the National Academy of Sciences*, vol 79, p 2278). But it resumed multiplying quite happily once the interferon was washed off—much like it would in the course of animal virus treatments. But is the human interferon truly mimicking the plant's own natural anti-viral factor?

Interferons trigger off a number of reactions in treated animal cells, and one of these—the manufacture of 2'-5' oligoadenylate (commonly known as 2-5A)—is also triggered off by the plant's virus-fighting chemical. This nucleotide is an important key in stimulating the cell to resist the manufacture of proteins, and effectively stopping the virus from replicating.

To test whether 2-5A was also involved in the plant reaction to the human interferon, Sela and two of his colleagues, Yair Davish and Sara Briggs, then applied 2-5A to tobacco leaves riddled with TMV (*Science*, vol 216, p 1415). The results were impressive—trace levels of 2-5A as low as $100—200 \times 10^{-12}$ molar almost completely halted the increase in virus population (although treatment had to be started early in infection to be successful).

A more direct approach to tackling virus fighting substances in plants is to culture batches of single leaf cells shorn of their rigid cell walls. This allows better monitoring of chemicals passing into or out of the cells. Loebenstein and A. Gera extracted an anti-virus factor from a variety of tobacco which forms local blotches to TMV—that is, has some resistance to the virus—(*Virology*, vol 114, p 132). This factor was easily sucked up out of the cells' culture bath, and helped protect other varieties of tobacco with much poorer resistance to the virus. Again, the factor had many of the chemical and physical hallmarks of animal interferons.

All these results most definitely point to one or more plant interferons, although none has been conclusively tested for one particular criterion of a genuine interferon—its effects on protein synthesis from RNA.

Nevertheless, they behave very much like chemicals that inhibit protein synthesis, and that mimic these virus-fighting factors in controlling or preventing disease.

So given that plants do make interferons, what use might we make of them? The magic wand of genetic engineering could conceivably be waved over sickly crop species, by transferring the gene(s) coding for interferon from virus-resistant species. But that will require a good deal of genetic and physiological research.

Perhaps more spectacularly, the plant interferons might help fight animal diseases. The few attempts made at this have all been unsuccessful, but then we have only scratched the surface of the vast numbers of animal viruses that could be tested. Or maybe the new interferons will give a convenient springboard for chemists to synthesise new medicinal drugs. □

Preserving wood

BRITISH scientists have made an important breakthrough in wood preservation. Researchers at the International Tin Research Institute (ITRI) have developed and successfully tested water-based wood preservatives using compounds based on tin.

Tin-based preservatives have the advantages over those used today of being neither potentially toxic, like substances using arsenic, chromium or copper, nor potentially carcinogenic like creosote. But until now, tin-based preservatives have used organic solvents, so fire risks and problems in storage have limited their usefulness.

Three years ago, chemists started playing with tin chemistry in attempts to make a water-soluble preservative. Tributyl tin was the starting point, a compound with good biocidal properties, but not water soluble. But by attaching methyl and ethyl-sulphonic acid molecules to the tributyl tin molecule, the researchers at ITRI have produced a water-soluble compound. Tests at Greenford showed that the new compounds have biocidal properties as good as those of copper-based preservatives. Tests in Canada showed the compounds are as stable in wood as other preservatives and do not leach out, which can be a problem with water-soluble compounds. □

Fish tell of tides

THE 18·6 long cycle over which tides raised by the Moon vary in strength has lately been implicated in a variety of environmental changes on Earth, including the repeating rhythm of droughts in the US midwest. Now, it has turned up in another set of records—the data on fish yields from the North Atlantic Ocean and the North and Celtic Seas.

Tim Wyatt, of the MAFF Fisheries Laboratory in Lowestoft, has pulled together data on the Arctic-Norwegian cod fishery, the herring fisheries of Iceland, Scotland, Norway and Sweden, mackerel and anchovy fisheries, and some for other species. The statistics go back to the 1880s, and among several periodic variations revealed by the analysis the strongest is the roughly 18-year rhythm (*Environmental Education and Information*, vol 3, p 137).

Wyatt speculates that although the lunar nodal tide, with a period of 18·6 years, has little impact on sea level at the surface, it is much more important as an influence on the depth of density discontinuities in the water layers below. This might explain, for example, why herring are only able to get in to fjords when the tide is at a peak, lifting the water layers they prefer over the floor of the fjord mouth. □

Diabetes marker

INSULIN-dependent diabetics with low blood concentrations of complement (C4) are seven times as likely to suffer complications involving the kidney and small blood vessels as are control diabetics and non-diabetics. (Complement aids the body's defences when antibodies combine with invading antigens.)

Confirming earlier findings that about a quarter of all insulin-dependent diabetics have microangiopathy (small blood vessel disease). A. H. Barnett and colleagues at Birmingham University and East Birmingham hospital think this may enable them to identify patients at risk of developing later disease.

Of 97 insulin-dependent diabetics studied, seventeen had severe microvascular complications. Of 26 with low C4 values, ten had severe and four mild microangiopathy (54 per cent). Furthermore, most (11) of the thirteen with protein in their urine (albuminuria), evidence of kidney damage, also had low C4 concentrations (*British Medical Journal*, vol 289, p 943).

The researchers suggest that low plasma C4 concentration may be inherited and a predictor of a microangiopathy-prone sub-group of insulin-dependent diabetics. □

El Chichón and the ozone layer

THE influence of human activities on the ozone layer pales into insignificance alongside the observation that a single major volcanic eruption increased the amount of hydrogen chloride in the stratosphere by 40 per cent over a large part of the globe. The volcano was El Chichón, which erupted in March and April 1982. The findings come from a study carried out at the US National Center for Atmospheric Research in Boulder, Colorado, and "should lead", say the authors, "to a reassessment of the role of volcanoes in stratospheric chlorine chemistry".

Could HCl produced after the eruption of El Chichón affect the ozone layer?

Stratospheric chlorine chemistry became of topical importance in the 1970s, when it was suggested that propellant gases from spray cans, the chlorofluorocarbons, might get into the stratosphere and break down to release chlorine atoms, which in turn would destroy ozone molecules, removing part of the blanket which protects us from solar ultraviolet radiation. The debate has swayed to and fro over the years, as chemists have revised and improved their modelling of the complex chemistry of the stratosphere.

In essence, there are two schools of thought. One argues that the ozone layer is a fragile bubble that may easily be punctured by thoughtless human disturbance to the chemistry of the stratosphere; the other view is that the complex web of stratospheric chemical reactions is a rugged system that is unlikely to be greatly disturbed by the kind of interference we are producing today. The El Chichón study is an invaluable input to this debate.

The data come from several flights made by an aircraft called the NCAR Sabreliner aircraft between July and October 1982. A spectrometer on board the aircraft was used to measure the spectrum of sunlight that had passed through the stratosphere, revealing the composition of the atmosphere above the aircraft.

The key figures from the resulting analysis by William Mankin and M. T. Coffey show that there was a 40-per-cent increase in the column density of hydrogen chloride in the cloud from El Chichón, equivalent to an increased burden of 40 000 tonnes of the acid, 9 per cent of the total atmospheric burden of HCl (*Science*, vol 226, p 170).

There are as yet no data showing any associated decrease in the ozone concentration of the stratosphere, but the relevant satellite observations are still being analysed. ☐

Dopamine and cot death

SUDDEN infant death syndrome (SIDS, or "cot death") may be related to an inborn defect in the metabolism or release of the naturally occurring catecholamines, particularly dopamine, that affect control of respiration. Dr D. G. Perrin and fellow paediatricians and respiratory physiologists at Toronto University and Hospital for Sick Children found that SIDS victims had 10 times as much dopamine (and three times as much noradrenaline) in their carotid bodies as control babies dying suddenly from other causes (*The Lancet*, vol ii, p 535).

The carotid bodies lie at the point at which the carotid artery branches to form the internal and external carotid arteries, and contain chemoreceptors that trigger off the reflex response to hypoxia (low oxygen concentration in the blood). The lungs, brain and blood-forming system of SIDS babies all show evidence of chronic hypoxia, suggesting an inability of the chemoreceptors to respond to this state, following a halt in breathing during sleep. The normal response of the carotid body chemoreceptors to hypoxia is to enhance the neural discharge to the brain's respiratory centre, thus stimulating an increase in the rate and depth of respiration. Dopamine, on the other hand, acts directly on the carotid bodies to diminish the neural discharge and the rate and depth of breathing, as well as inhibiting the response of hypoxia.

Had the high catecholamine content been secondary to the hypoxia, Perrin argues, they would have expected to find an increase in the size or volume of the carotid body cells to result, an effect seen in both humans and rats. As this hyperplasia did not occur in the SIDS cases, they conclude that an intrinsic abnormality of metabolism or release of dopamine is the more likely explanation. *The Lancet* warns in an editorial, however, that more evidence is needed before this interpretation of the features of SIDS is accepted. ☐

Why pygmies can't grow taller

THE tallest pygmies who live in the tropical rainforests of central Africa grow to a mere 1·45 metres high, substantially shorter than their Bantu neighbours with whom they mix but do not mate. They also differ in their proportions: pygmies are more muscular, sway-backed and short-legged. Some anthropologists regard them as a separate race from Negroes, but their blood groups are similar. So, interestingly enough, are their levels of growth hormone. Growth hormone produces many, perhaps all, of its effects by converting liver peptides into growth-promoting substances called IGFs (insulin-like growth factors). There are at least two of them, IGF I and II. They are similar to insulin, both in structure and function, but IGFs are 50 to 100 times weaker in their hypoglycaemic (capacity to lower blood sugar) effects, and many times stronger in their anabolic (tissue building) properties. IGF I, whose formation is completely dependent on growth hormone, is three times as active a growth-promoter as IGF II, which is much less dependent on growth hormone.

Both pygmies and pituitary dwarfs (people with growth hormone deficiency) have low levels of IGF I. When injected with growth hormone, IGF I levels rise to normal in pituitary dwarfs, but remain low in pygmies. Professor Rudi Froesch and colleagues at Zürich University, who discovered this (*New England Journal of Medicine*, 1981, vol 305, p 965), believe that deficiency of IGF I is the true cause of pygmydom—they do not suffer from malnutrition: they do have normal levels of growth hormone, and they are unresponsive to the hypoglycaemic effects of insulin. "The riddle of the small size of the pygmies" says Froesch, "has been solved".

He and his colleagues have found that a similar deficiency accounts for the size of miniature and toy poodles—Standard poodles have normal levels. ☐

Beryl seldom flares up

Beryl B, Mobil's newest North Sea oil production platform, doesn't go in for flamboyance. Instead of lighting the night sky with a fiery display from her flare stack, Beryl B plans on holding back the burning off of excess gas. There will, however, be more to Beryl's comparatively small flame than mere modesty.

The natural gas that bubbles to the surface with oil is far too valuable a commodity to waste on pyrotechnics. Instead, Beryl B will *use* that gas. Some of it will fuel the platform's new Rolls Royce-driven generators. These, in turn, are to run a compressor to force the gas back to the subsea wells under pressure of more than 5,000 pounds per square inch. There, the gas is going to help to force more oil to the surface than would otherwise be possible. And with that oil will come still more gas to continue the cycle.

From a fiscal point of view, every one percent increase in oil production in the North Sea brings about £80 million a year to the Exchequer. More importantly, though, gas injection as planned for Beryl B helps to conserve a significant energy source for future needs.

Of course, Beryl B won't be unique for the small size of her flame. Sister platform Beryl A's flare is already the picture of discretion. And so it should be. Seven years ago Beryl A was the British North Sea pioneer in gas injection and ever since she's led the field in gas conservation.

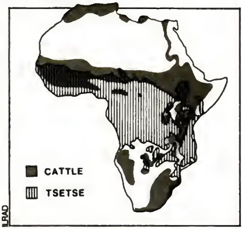
Even now, few of her neighbours can hold a candle to her.

Mobil Beryl B

Mobil North Sea Limited

A vaccine for trypanosomiasis

Bob Johnstone

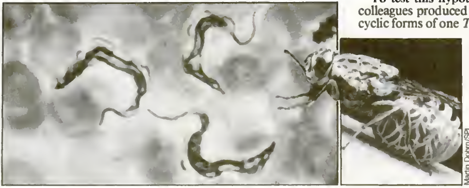


ADVANCES in the techniques of tissue culture have brought control over trypanosomiasis, the parasitic disease that is the scourge of livestock in tropical countries, one step closer. Cell biologists working at the International Laboratory for Research on Animal Diseases (ILRAD) in Kenya have for the first time used trypanosome parasites grown in tissue culture to make a vaccine.

In Tokyo last month on a fund-raising mission, Hiroyuki Hirumi, leader of ILRAD's team of cell biologists, described how years of methodical research had led to the development of the vaccine.

The threat of trypanosomiasis keeps livestock, most importantly cattle, out of the part of Africa best suited to it. This swathe of humid woodland savannah, larger than the US, is known as the tsetse belt, after the fly that carries the disease (see map). If the tsetse belt could be made safe for cattle, then Africa could double its production of animal protein.

Though scientists have been investigating trypanosomes since the early 1900s, a big stumbling block has been their inability to come up with effective methods of culturing the parasites in the laboratory. So because there has been no way of developing vaccines, the ideal method of control, most effort has gone into trying to control the tsetse fly—with insecticides, bush clearances, or, most recently, the release of radioactively sterilised males—rather than the trypanosome it carries.



Developing a vaccine to kill trypanosomes (above) may soon prove easier than controlling the tsetse fly (right)

ILRAD was established in 1973 to develop immunological control over trypanosomiasis (and that other scourge of African cattle, East Coast Fever). It was faced with a formidable biological problem. To begin with, there are three main species of trypanosome, *T. brucei*, *T. congolense* and *T. vivax*. *T. brucei* is itself divided into three subspecies: *T. b. brucei*, which attacks cattle, and *T. b. rhodesiense* and *T. b. gambiense*, which attack humans. Though all species share the same basic lifestyle, each behaves differently, thus requiring development of different handling methods.

The parasite's life cycle is itself also complex. Though only single-cell organisms, trypanosomes are extremely robust, as they have to be in order to survive the vastly different environments of fly gut (or mouth) and mammal skin and bloodstream. When in the former, trypanosomes are non-infective. As they prepare to enter the latter, however, they don a thick surface coat of glycoprotein antigens to protect them from the mammalian host's antibodies.

Once in the bloodstream, trypanosomes have the ability to vary the molecular structure of this coat—that is, alter its antigens very quickly—thus keeping one step ahead of the host's antibodies. Sucked up into the fly, the parasites slough off their coats, becoming non-infective once more.

Before work could be done on antigens, methods of culturing all stages in the life cycle of all species *in vitro* (in a laboratory dish) had to be developed. When ILRAD was established, despite considerable efforts, the most researchers had managed to achieve was the culturing of the non-infective (fly gut) stage in two species only. This meant that the only way to study the parasites in their infective stages was repeatedly to infect livestock animals with flies. This was both expensive and inefficient—one bite from a fly could yield as few as 20 trypanosomes.

One of ILRAD's most important initial tasks was therefore to culture and propagate the parasites in their infective form. The World Health Organisation predicted it would take them 10 years: ILRAD's scientists pulled it off, using an isolate of *T. brucei*, in six months.

From that first breakthrough, work has proceeded step by step, both at ILRAD and elsewhere. By 1980, *T. b. brucei* had been persuaded to go through its complete life cycle *in vitro*. (This has had an immediate application: *T. b. brucei* culture systems are now being used to screen new trypanocidal drugs.) In 1981, scientists at Edinburgh University developed a way to cultivate infective-stage *T. congolense* parasites, starting from the mouth part of the fly. In 1982, scientists from the Swiss Tropical Institute, working with colleagues at ILRAD, developed a culture system for the bloodstream form of *T. vivax*, the most delicate and hence most difficult species to culture.

By the end of last year, ILRAD had succeeded in culturing all three species for at least one isolate, and in some cases for several. And, using a modified version of the Edinburgh University technique, ILRAD's cell biologists were now able to produce 100 million to 200 million infective *T. congolense* parasites per day.

In the past, development of a vaccine against trypanosomiasis was thought impossible because of the number—perhaps over 100—of antigens associated with the trypanosome's surface coat. Now, with sufficient *T. congolense* parasites available for detailed research on the forms, mechanisms and variety of antigens, researchers made an important discovery.

In its metacyclic form (that is, when it has donned its antigen coat ready for the journey into the mammalian host) the parasite appears to have far fewer antigens than it later develops once in the bloodstream. Better still, apparently the same serodeme (set of antigens) appears each time the parasite returns to this stage. Thus, though it might not be possible to immunise animals against the bloodstream form, would it not be possible to immunise against this initial infective form?

To test this hypothesis, Hirumi and his colleagues produced a vaccine using metacyclic forms of one *T. congolense* serodeme produced *in vitro*, then killed and broken down by ultrasound. In the crucial series of experiments, eight goats were vaccinated. Two months later they were bitten by tsetse flies infected with the same serodeme. All eight resisted infection, whereas 11 controls caught the disease and died.

Despite this very clear-cut result, much work remains to be done before ILRAD's team can try its vaccine in the field. The next step is to test whether the vaccine, produced from a serodeme isolated in Serengeti 10 years ago, will cross-react with three new strains isolated from the Kenya coast. If even one of the set of antigens is the same, that could produce a cross reaction. The ultimate challenge is to produce immunity against many different serodemes. In the short term, ILRAD's epidemiologists are looking for areas (like the Kenya coast) with a limited number of serodemes where they can carry out field studies.

Dr Hirumi has no illusions about success coming any quicker in the future than it has in the past. The parasites, as he admits ruefully, are still "much, much smarter than humans—whenever we understand up to some levels, they do completely unexpected things which we cannot understand." ☐

TECHNOLOGY

The drag on fuel efficiency

Mick Hamer

DRAG COEFFICIENTS are a major talking point at this week's motor show. The new Panther sports car, for example, which was unveiled at the show, has recorded a drag coefficient of under 0·3 in tests at the Motor Industry Research Association.

Drag coefficients are one of the key selling points for economy conscious motorists. The current advertising copy for the Renault 25 says that the car has "an aerodynamic body that is both very elegant and very efficient". The TS version has a drag factor of 0·28, the lowest figure for a production car in the world.

Renault is far from the only car maker to boast of its aerodynamics. In recent months the difference in aerodynamics of two cars has been graphically demonstrated on our television screens by a car towing a parachute. And "that rakish profile" of Mitsubishi's new Lancer has "flush surfaces, concealed wipers and a laminated windscreen angled at precisely 30·5 degrees". All of which helps give it a drag coefficient of only 0·38. Easily one of the best in its class. "The aerodynamics of the Lancer help make it one of the most economic cars we've ever produced," says the advertisement. The message is clear. Good aerodynamics, and low drag factors, add up to good fuel consumption.

Now for one hard fact. The car with one of the highest drag factors is Citroen's Deux Chevaux. It is also one of the least thirsty cars.

Of course, the Deux Chevaux can not be compared directly with cars that have engines two or three times larger. Nevertheless, the contribution of aerodynamics to fuel efficiency is vastly overrated, and the drag coefficient is virtually irrelevant.

New Scientist examined the government's official fuel consumption figures, at a constant 120 kilometres per hour, and the drag coefficients of 15 current models. All of the cars had 1600 cc engines, and five-speed manual gearboxes. The drag coefficients varied from 0·38 to 0·47. The fuel consumption varied from 7·1 to 9·0 litres per 100 kilometres. Yet statistically there was no connection between these two sets of figures; none of the variations in fuel consumption could be explained by the drag coefficient. The Honda Accord, for example, has a drag factor of 0·38 and a fuel consumption of 7·8 litres/100 km. Yet the Peugeot 305, with a drag coefficient of 0·45, has a fuel consumption of 7·1 litres/100 km.

The aerodynamic drag of a vehicle depends on three factors. It is directly proportional to the drag coefficient, which is a measure of how smoothly air flows over a shape. It is also directly proportional to the frontal area of the vehicle, and to the square of the vehicle speed.

Renault

Aerodynamically sound, but does it save fuel?

The product of the drag coefficient and the frontal area of a car gives a better idea of how much aerodynamic drag a car has. Of the cars which *New Scientist* compared, 45 per cent of the fuel consumption at 120 km/h could be explained by the product of the drag coefficient and the frontal area. The rest of the variation in fuel consumption is the result of other differences between the cars—such as rolling resistance and vehicle weight.

Of course fuel consumption at a constant 120 km/h is, at least in theory, academic for British drivers, since the maximum speed limit is 112 km/h (70 miles/h).

So we compared fuel consumption figures issued by the Department of Transport (DoT) for a constant 90 km/h, with the drag coefficients and frontal areas. Only a third of the variation in fuel consumption could be explained by the aerodynamic drag.

Similarly, the fuel consumption figures for the DoT's urban cycle, a mixture of stops and starts designed to represent typical town driving, were not statistically related to the aerodynamic drag.

The reason for this lack of importance of aerodynamic drag at slow speeds is that the drag is proportional to the square of the vehicle speed, while rolling resistance, for example, increases linearly with speed. Under 65 km/h, rolling resistance is a much more important source of energy loss than aerodynamic drag.

One of the clues to the popularity of aerodynamics in the car adverts is that high-speed driving is a lot less common than many motorists think. Only 10 per cent of the mileage driven by cars is on motorways. And only about one-fifth to one-quarter of the mileage is on roads where motorists could indulge in sustained high speed driving.

Far more typical of the use to which most cars are put is a relatively short drive to work, or the shops. Eight out of 10 car journeys are less than 16 km. Other factors far outweigh the effect of drag on fuel consumption over such short distances. One of the most important of these is the fuel penalty of starting from cold. When warm, an average car might consume about 0·1 litres/km. Yet when starting from cold the fuel consumption can easily be double for the first kilometre, and the car will not be fully warmed up for at least 16 km, and perhaps further in winter.

Another reason why motorists can forget about aerodynamics is that cars have a practical use. The extremely low drag coefficients are obtained in wind tunnels, with the car in perfect condition. Just open the window and you immediately raise the drag coefficient. Drive behind a large lorry and the turbulence engulfs the most aerodynamic outline. All external accessories, such as aerials, wing mirrors and mudflaps raise aerodynamic drag.

Rather than worrying about aerodynamic drag, most motorists can easily save fuel in other ways. Making sure the tyres are pumped up to the right pressure will cut rolling resistance. Avoiding sharp braking is the surest way to save fuel, because if your car has lost kinetic energy then the engine has to work to build up the speed again.

This heresy applies equally to car designers. Although there is no point in designing a car with more drag, advertising copy is the only tangible return from lowering drag coefficients still further.

Most saloon cars now have a drag coefficient of around 0·35 to 0·45. Racing cars have much lower drag coefficients, and drag coefficients of 0·1 has been quoted for cars that have made attempts on the land speed record. Of course, at these speeds aerodynamic drag is extremely important. But the average saloon car driver is not planning an attempt on the land speed record up the M1.

The aerodynamic drag of a saloon car, unlike a racing car, is limited by the practical design need of creating a box which will contain four people sitting down. This shape determines the frontal area, and all the aerodynamicist can do is to smooth down the rough edges. Of course, the drag could be cut sharply by making the four passengers sit behind one another, because ▸

of the reduction in frontal area. But would it sell?

The returns from improvements in aerodynamics are much less impressive than, for example, making lighter cars. In our group of 15 cars, we can estimate that cutting the drag by 1 per cent would reduce fuel consumption by only 0·25 per cent.

Cutting the weight of cars is a much more profitable area for research. For a start the returns are more impressive. A 1-per-cent reduction in weight will reduce fuel consumption by around 0·7 per cent. Secondly, weight has its greatest impact on fuel consumption in urban driving. And thirdly, many of the new materials that can cut car weight are just around the corner.

The increasing use of plastics for body parts and ceramics in engines are likely to do more to cut fuel consumption than any improvement in aerodynamics.

For anyone considering buying a new car the best counsel is to ignore aerodynamics, and the advertising copy. If you are concerned with fuel economy then the best advice is to look at a car with a smaller engine. Not only will the engine use less fuel but the car will be lighter. That is the reason why the Deux Chevaux is just about the least thirsty car on the market. ☐

Hot, dry power

A NEW PHASE of the hot dry rocks project at Camborne in Cornwall begins this week. Drilling should start at the weekend on a third well which will be the deepest on the site when it is completed next February.

The new well should clear up some mysteries created by earlier work on the site. But even before it is drilled Dr Tony Batchelor, the director of the geothermal research project is predicting that a power station taking its heat from hot dry rocks in Cornwall could sell to the domestic consumer at 4 to 4½ pence per kilowatt hour, at least a penny cheaper than the current price.

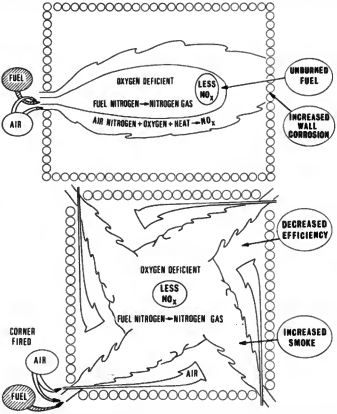
In November 1982 two wells, 2200 metres deep, were connected underground by setting off explosive charges and pumping down water under pressure, to create and widen a network of cracks to act as a heat exchanger and heat water pumped down one well and up the other. Instead of running horizontally the cracks ran downwards and the network, or reservoir, created was five times more extensive than expected, and thus swallowed up most of the water pumped down. The cracks were also narrower than expected because they were created by rock faces sliding over each other, rather than being levered apart by water pressure.

So the deeper, third well will curve under the first two and tap water from the reservoir. When the third well is drilled, the reservoir will lead down to hotter rocks than it reaches now. And the cracks in the reservoir can be widened by pumping down water which contains a viscous additive. The technique has been tried experimentally at Camborne with excellent results.

Batchelor calculates that a power station tapping rocks at a depth of 6000 metres and producing five megawatts of power could be built in four years for £18 million, producing cost-competitive power. ☐

CEGB tackles acid rain at source

BRITAIN'S power stations will have no technical reason for contributing to acid rain if a new research programme succeeds. The Central Electricity Generating Board last week announced a new impetus for its work on a coal furnace that produces much less oxides of nitrogen than existing power stations do (*New Scientist*, 11 October, p 5).



Oxygen-deficient combustion can cause corrosion (top) even though it reduces the oxides thought to cause acid rain

Power stations contribute 45 per cent of the oxides of nitrogen in Britain's air. Two substances are involved, nitric oxide and nitrogen dioxide. The popular abbreviation for mixtures of them is NOX (for NO_X). In the upper atmosphere, NOX reacts in the presence of sunlight to make nitric acid. Reactions may also involve hydrocarbons and sulphur dioxide, the main pollutant from coal-fired power stations.

In the past, attempts to control acid rain have focused on cutting emissions of sulphur dioxide. This is partly because processes to remove sulphur from flue gases are relatively well understood (*New Scientist*, 13 September, p 10). The CEGB has always rejected calls to control emissions of sulphur dioxide (SO_2) on the grounds of cost and uncertainty about any benefits. "If reducing SO_2 emissions would solve real environmental problems in the most cost-effective way, we will get on with the job despite the costs," said Sir Walter Marshall, the board's chairman, last week. "But if hydrocarbons and NOX are the real problem that would be a waste of money."

Marshall said that a main goal of the CEGB's research on preventing pollution would be to bring technology for controlling NOX to the same level as that for reducing emissions of SO_2.

Power stations in Japan already remove NOX from flue gases with a catalytic process. The CEGB's reseachers are concentrating on a more elegant approach—burning fuel so that it produces less NOX in the first place.

The principle, called staged combustion, is easy to understand. The boiler burns fuel in two stages, the first in a restricted supply of air. In such conditions, nitrogen in the fuel becomes nitrogen gas rather than nitric oxide.

The problem is that running burners to produce less NOX reduces their efficiency and causes corrosion.

Corrosion happens when substances such as chlorine in the coal react with the walls of the furnace instead of with oxygen. The answer, according to Dr Dick Clapp of the Central Electricity Research Laboratories is to modify the flow of air inside the furnace. Ideally, combustion should be starved of oxygen when necessary, but air should flow along the furnace walls.

Some of the CEGB's boilers are comparatively easy to modify. They have corner-fired furnaces, in which combustion takes place in a central fireball, rich in fuel. Adjusting the angle of the inlet jets allows air to circulate around the fireball, preventing the build-up of corrosion which happens when oxygen-deficient combustion occurs next to the wall of a furnace. Trials of a modified corner-fired burner will begin at Fiddler's Ferry power station, in Merseyside, next year. The CEGB expects to know by the end of next year how much improvement will come from the boiler.

Most of the CEGB's power stations have a different type of boiler, the wall-fired type. These have rows of burners, which produce a series of flames. To modify for low-NOX combustion, it is necessary to redesign the aerodynamics of the burners. The CEGB has commissioned Northern Engineering Industries to design a prototype low-NOX burner, and expects to be testing a full-scale version in 1986.

But proving the technology is only half the battle. The CEGB says that it would cost about £90 million to convert all its modern coal-fired stations to "low-NOX" burning, and the loss in efficiency would put £9 million on electricity bills every year. It will need a cast-iron verdict on oxides of nitrogen before it decides to spend this money. ☐

Scientists seek to turn methanol glut to profit

CHEMISTS in France and Britain are looking at ways to improve the conversion processes of methanol to gasoline and to acetic acid. There is a world glut of methanol, which is synthesized from carbon monoxide and hydrogen as a feedstock for the petrochemical industry.

French chemists are investigating how zeolite catalysts convert methanol into gasoline; research that could lead to improved gasoline yields by this process. Meanwhile their British counterparts have learnt a new way of converting methanol into acetic acid without carbon monoxide, so making an already cost-effective synthesis potentially cheaper.

Since the early 1970s, when Mobil discovered how methanol could be converted to gasoline over a zeolite catalyst, chemists have beavered away in search of a mechanism for this reaction. Know the mechanism and you have a powerful handle on the reaction that can ultimately increase yields. And as methanol is so cheap, it could rival oil as a gasoline source. Zeolite catalysts consist of aluminium, silicon and oxygen atoms arranged in such a way that methanol molecules can move among them and react.

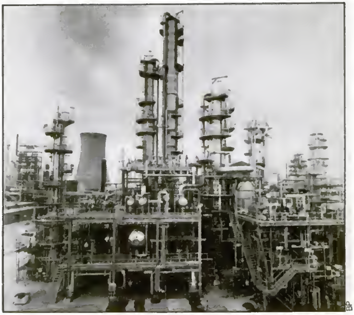
A French team, led by Paul Rimmelin and Jean Sommer at the Louis Pasteur University in Strasbourg, thinks it has sorted out one of the key steps in the methanol-to-gasoline reaction pathway.

While most chemists agree on the first step, conversion of methanol to dimethyl ether, the mechanism of the second step, formation of carbon-carbon bonds, has caused problems. The most attractive hypothesis to date says that an intermediate, called an oxonium ylide, is first formed. This is a species containing a negatively charged carbon group connected to a positively charged oxygen group. This then reacts to produce carbon-carbon bonds.

Rimmelin and Sommer tested this hypothesis by synthesising an oxonium salt and reacting it with a strong organic base, called tetramethylpiperidyl lithium. The base pulls a proton off one of the oxonium salt's methyl groups, forming the oxonium ylide. The French chemists reasoned that the ylide could then react in a variety of ways which should all produce methyl ethyl ether. This is precisely what happened. So in the methanol-gasoline reaction, methanol goes first to dimethyl ether, then to an oxonium salt which forms the ylide. Finally, the ylide reacts further to give methyl ethyl ether. This is the first step in the formation of the long gasoline, hydrocarbon chain.

There is a snag, however. For the reaction to work, the base has to be of a type known as "hindered". This means that the active site on the base is surrounded by large blocking groups that hinder close approach of anything larger than a proton. Without this hindrance, the base could abstract a whole methyl group from the oxonium salt. This would prevent formation of the ylide and kill the reaction.

If the Strasbourg team's mechanism is correct, then the zeolite catalyst should contain hindered basic reaction sites. The trouble is that nobody knows the nature of such sites. Once they do, it should be possible to tailor zeolites with more basic sites that will ultimately improve gasoline yields.


Acetic acid plants could get a boost from methanol

The British group, led by Professor Peter Maitlis at Sheffield University and backed with money from BP, turned its attention to an, as yet, unexploited property of methanol—its power to act as a hydrogen donor in certain catalytic reactions.

Hydrogen is the obvious choice for catalytic hydrogenation reactions, but it suffers from a number of disadvantages. It is expensive, not easily handled, and has only low solubility in organic solvents. Organic solvents are the media of choice for homogeneous catalysis where the catalyst dissolves in the reaction medium. The advantage of a homogeneously catalysed reaction is that it is clean, generally giving no more than two products which are easy to separate.

Methanol is an ideal hydrogen donor for homogeneously catalysed reactions because each molecule can give rise to two molecules of hydrogen. Methanol is also soluble in the reaction medium.

Maitlis tried reacting methanol with a type of hydrogen acceptor called a ketone in the presence of a catalyst.

The ketones, which are molecules with a double bond between oxygen and carbon, were reduced to alcohols, in most cases, but the methanol was oxidised to methyl formate. Now methyl formate is an interesting by-product because it can easily be rearranged to another very useful chemical feedstock, acetic acid. This contains two carbon atoms, as opposed to methanol's one. As most of the interesting industrial chemistry starts from C-2 compounds, like acetic acid, the Sheffield synthesis makes a glut of methanol (at a current knockdown price of \$140/tonne) a very exciting proposition. ☐

Stilted-speech recognition

A TEAM at IBM's Yorktown Heights laboratory in New York has produced an experimental word processor which responds to the human voice. The system is capable of taking dictation from a human operator and translating spoken words into text on its screen. IBM claims that the system can identify 95 per cent of the words spoken into its microphone correctly.

Like all voice recognition systems the one developed at Yorktown identifies spoken words by matching measurements of their energy levels with measurements already stored in its memory. The system has a 5000 word vocabulary.

In addition to this, the machine attempts to predict what word will come next from the combinations of words already spoken. The system's forecasting is based on a statistical analysis of 25 million words which has enabled the IBM researchers to establish commonly occurring groups of words. Both the forecast and the matching process are used to identify a word. Sometimes, especially with longer words, the system relies entirely on the acoustic evidence. In other cases, particularly with short words like to, too and two, the system turns to the statistical evidence.

Three years ago IBM abandoned work on continuous speech recognition in an attempt to produce a system that could be tested with people. Operators have to speak slowly into the latest voice recogniser to create distinct pauses between words.

Continuous speech presents problems in deciding when one word begins and another ends, and involves almost continuous sampling of voice patterns. However, Dr Fred Jelinek, leader of the voice recognition group, is confident that continuous speech recognition will be possible.

But, unlike other researchers who believe that to recognise continuous speech, computers must also understand their meaning, Jelinek says that statistical methods are enough. He has constructed experiments in which people were asked to predict what letters would come next in a piece of text and found that his system was just as effective as they were in guessing the right answer. Their knowledge of the language and the subject matter did not make much difference.

Office workers are unlikely to be using listening typewriters of whatever kind for some time to come. If it were available, the IBM system would probably cost £700 000 for the hardware alone. ☐

Britain puts its money where its discs are

A BRAVE financial gamble by a small company—Nimbus—makes Britain the only country, other than Japan, to have its own pressing plants for the three types of high-density, disc-recording systems.

The Dutch company Philips built a plant to press grooveless videodiscs which are read by laser, and Thorn EMI is making grooveless VHD videodiscs which are tracked by an electrically conductive stylus. But none of the record companies in Britain was prepared to invest in plant for pressing compact audio discs. Until now the only compact disc factory in Europe was in Hanover. It is owned jointly by Polygram, Philips and Siemens of West Germany. Now Nimbus, an independent company which already makes its own classical recordings and custom presses vinyl LP records for other record companies, has built a compact-disc factory in the grounds of its headquarters in Herefordshire.

Nimbus raised the £2 million finance for the factory privately because it did not qualify for an industrial development grant from the government. The company could have had hundreds of thousands of pounds in cash aid had it been prepared to build its factory in a city designated a development zone. But compact disc manufacture, like microchip production, needs surgically pure conditions, and the company opted for a site where the air and water are easy to clean and filter.

Polygram, Nimbus's only other competitor in Europe, started pressing compact discs in Hanover in August 1982. Demand for the discs is high, and the only other factories producing them are CBS-Sony, Sanyo, Toshiba, Denon and JVC in Japan. The Nimbus plant more closely resembles the Japanese factories than does Polygram's facility in Hanover.

The first stage of compact-disc production is to make a metal stamper for pressing. This carries a negative impression of the tiny information pits which are moulded into the pressed disc. To make the sampler, a clean glass disc is coated with photoresist material and spun under a laser which is modulated with the digital sound signals to be reproduced. The exposed glass master is developed, etched and electroplated through several stages to make the negative replicas.

The stamper is loaded into an injection moulding machine which produces transparent 12-centimetre discs from hot polycarbonate plastics. Nimbus can make one disc every 21 seconds, but hopes to improve this to one every 15 s—this is the rate achieved in Japanese factories. Because of the type of injection mould employed by Polygram, the factory in Hanover has a longer cycle time at one disc per 25 s.

Nimbus also saves production time by pressing discs which already have a centre hole of full size. Again this is similar to the approach adopted by Japanese companies. Polygram presses the discs with a small centre hole, and at a later point centres the discs and punches out a full size hole.

Once pressed, the polycarbonate disc is coated with a thin layer of metal to make it reflective for the laser readout in the player. Here Nimbus and Polygram face the same problem. Aluminium is evaporated and the vapour settles on the discs which are suspended in a vacuum chamber. It takes 30 minutes to evacuate the chamber so, although several hundred discs are coated at a time, half an hour must elapse between one batch entering and another leaving the chamber. When the disc has been coated with metal, it is coated with a lacquer to prevent the aluminium oxidising and to protect the disc from fingerprints.

A comparison between compact discs and conventional vinyl LP records highlights the practical difficulties of making compact discs. The width of a groove in vinyl LPs is about 50 micrometres. The undulations in the groove are tracked by a diamond stylus that has a curved tip with a radius of 15 micrometres. The information pits on a compact disc are 0·1 micrometres deep and 0·6 micrometres wide, and the readout laser focuses on a point 1 micrometre in diameter. The protective lacquer must be exactly 1·2 millimetres thick otherwise it will defocus the readout laser. So factory tolerances for compact discs are 50 times tighter than for conventional records.

The air inside the Polygram and Nimbus factories is filtered so that there are no more than 100 dust particles of 0·5 micrometre diameter in every 30 square centimetres of air. The workforce are robed in protective clothing and no visitors are allowed inside the clean room during production. By contrast, some British record makers have allowed smoking on the shop floor.

Nimbus's investment is already paying off. It has pressed discs for the BBC and EMI. The first pop compact disc ever produced in Britain—Elkie Brooks' Screen Gem—is in the shops now. EMI has taken the unprecedented step of issuing the compact disc version a couple of months before the conventional vinyl disc or musicassette. ☐

Compact discs emerge with their coating of aluminium

A pocketful of music

THE GADGET FREAK who has everything, can have something really different this Christmas, thanks to Sony of Japan. The D-50 is a portable compact-disc player only slightly larger than the plastic box that protects a compact, disc record. You can, quite literally, put it in your pocket.

All the features found on bulky domestic players, like automatic searching out of a pre-selected music track, are on the portable. The digital signal-processing circuitry has been integrated onto a single chip. The player can run off a battery pack, mains adaptor or car cigarette lighter plug. It weighs 590 grams. The compact disc it plays measures 120 mm.

Hi-fi sound is heard through headphones, or the player can be plugged into a full-blown domestic hi-fi system. If we had not tried it ourselves, we would have suspected a hoax.

Sony will start selling the D-50 in Britain from 1 December, for £280; The price in the US is only $299. The higher price in Europe, notes Sony bitterly, is thanks to the 19 per cent levy on compact-disc players now imposed by the EEC at the request of Philips, which Sony helped make compact discs the world standard for gramophone records.

Now the gloves are off. Sony admits it was ready to launch CD in October 1982, but held back until March 1983 simply to keep Philips happy. The Japanese company intends teaching Philips a lesson for the delay and levy. The portable player is Sony's first move to collar the headlines and CD market. Early next year the company will start selling compact disc players small enough to mount in a car dashboard. First production models are being demonstrated this week at the Motor Show.

Sony is the first company to prove to sceptics that the laser in an in-car CD player can keep on tracking even when the vehicle is driven over a bumpy road. ☐

Well done, Beryl!

It isn't easy being younger sister to a well-established star.

Luckily, Beryl B, sibling to Mobil's well-established Beryl A production platform, has a lot to offer on her own terms.

Supported by a steel jacket that weighs only a fraction of her sister's concrete bulk, Beryl B nevertheless stands tall and firm (with 130 foot pilings into the seabed to withstand the worst that the North Sea can come up with).

Inside, she's been equipped with Rolls Royce-driven generators supplying 39 megawatts – enough power for a town the size of Inverness. Moreover, that power is put to good use, injecting excess gas back into the oil reservoir to force yet more crude to the surface.

Beryl B's upbringing has been an expensive affair. To date, the platform has cost some £400 million, with more than 80 percent of that total spent here in the UK on the products and services of more than 400 contractors.

At peak, Beryl B gave employment to more than 5,000 people and overall involved 13 million man-hours of work.

Now, just over four years since inception, Mobil's Beryl B officially came of age, with an inauguration ceremony on 17 October.

Beryl B might not have been the first girl on her block. But with the potential to recover 300 million barrels of oil in her long lifetime, she does come in a close second.

Mobil North Sea Limited

Amerada Hess, Enterprise Oil, Texas Eastern & Mobil

REVIEW

The best of all possible worlds

The Resourceful Earth
by Julian L. Simon, Herman Khan and others,
Basil Blackwell, pp 585, £14·95

William Clark

NOT SINCE Voltaire wrote *Candide* in the 18th century has there been such a paean of optimism as *The Resourceful Earth*. This guided tour of the best of all possible worlds is an engine for the renewal of self-confidence in the American people which appears to be sweeping Ronald Reagan back into the White House, and the world back into that American Century proclaimed by Henry Luce in 1945 as a riposte to Henry Wallace's "century of the common man".

This bulky work by a group of a couple of dozen scientists—mostly American—seeks to demolish the pessimistic thesis of resource shortage that was well publicised in the Club of Rome's report *Limits of Growth* and more recently in President Carter's final prophetic work *Global 2000*, which foretold mass poverty, malnutrition and deterioration of resources by the end of the century. Julian Simon, the principal editor, states categorically that: "Environmental, resource and population stresses are diminishing and with the passage of time will have less influence than now upon the quality of human life on our planet." He proposes that "trends strongly suggest a progressive improvement and enrichment of the Earth's natural resource base, and of mankind's lot on Earth".

Disagreement with the well-publicised warnings of *Global 2000* is complete:

> The public will be best served, both in price and availability with respect to natural resources such as copper and oil . . . if the government takes no actions at all that affect production and distribution, except for building strategic stockpiles."

Simon believes that the public should be kept in the dark about issues concerning resources, environment, and population. In his view the public has been "badly served by having been scared by a very large volume of unfounded and, or exaggerated warnings about these matters."

> "The US public must come to hear the truth that conditions have been getting better rather than worse and that enthusiastic and vigorous efforts to do even better, even faster will benefit the public as well as the individuals who act economically to bring about this social progress.
>
> "Recommendations to other countries—and even more so, pressure upon them—to institute and carry out policies with respect to their population growth rates are not warranted by any facts about resources or population, and they constitute unjustifiable interference in the activities of other countries, because such policies must necessarily rest upon value judgements. Hence, we consider that such recommendations by the Global 2000 movement are unfounded and unacceptable, ignorant and arrogant."

John Storey

The impact of these views on the US government became apparent at the Mexico City population conference in August this year when the US spokesman repudiated the conclusion of *Global 2000* that the population explosion was any cause for concern.

The Carter manifesto was open to some criticism for sloppy editing and muddled use of both models and trend lines. Simon makes the most of these errors while claiming that *The Resourceful Earth* is less bureaucratic and more scientific. Readers must judge for themselves. For example, the *Global 2000* charge that by the end of the century the Earth will be more crowded is met by the claim that since 1900 the American people have more floor space and more access to parks than ever before. This "suggests to us that the world is getting less crowded by reasonable tests relevant to human life". Tell that to the pavement people of Calcutta, Lagos or Mexico City.

Simon's cardinal criticism of *Global 2000* is that it does not take account of long-term trends, but only of the little local difficulties in recent years. The perils of population increase are dismissed thus:

> "Viewing the long sweep of human history, larger population size has been a clear-cut sign of economic success and has accompanied improvement in the human lot. The growth in numbers over the millenia, from a few thousands or millions living at subsistence to billions living well above subsistence is proof positive that the problem of sustenance has eased rather than intensified . . . In the long run human beings are the only possible source of human progress."

What he is saying is that the more humans there are the more human progress there is; there are no limits of growth. This is exemplified by reference to other long-term trends, such as the rise in average income for the world's population, including income in the poorer countries, which has been rising at "a percentage rate as great or greater than in the richer countries since World War II". World food prices have been trending lower for decades and centuries, and Simon feels there is strong reason to believe that the trend will continue.

Another trend, which is not mentioned, is the widening of the gap in income and resources between the one-fifth of humanity that lives in the industrialised countries, and the four-fifths that does not, including the 800 million who live an inhuman existence below the absolute poverty line. People cannot live by averages alone.

This omission may be the fatal flaw in the optimistic scenario portrayed here—in which more and more people consume more and more of the Earth's fruits, their progress fuelled by unlimited nuclear power, "the safest form of energy known to man". It may well be true that the generation of electric power by nuclear means will cause fewer deaths than deep mining coal. But the spread of fissile material around the world, which will inevitably become available to unscrupulous persons and governments, presents a fearful danger to an inequitably divided world community in which the great majority of wealth and power is in the hands of a small elite.

The Resourceful Earth quite accidentally demonstrates how little certainty there is about the present (let alone the future) state of global resources, and yet how crucial to our survival such knowledge is. If the obvious shakiness of the statistics and the incredibility of the confident projections do little to upset the credit of *Global 2000*, it may strengthen the hands of those of us who have been calling urgently for as firm a statistical base as possible whereon to judge the state of our planet's resources.

To pretend, by the unscientific manipulation of "trend-lines", that all will be for the best in the best of all possible worlds, if only we let the magic of the market place have full play, is dangerous necromancy. Yet the only note of dissent by the scientists writing in this book is horrifically revealing. Bernard Cohen, professor of physics at Pittsburgh, complains that because the forces of ignorance are overcoming the wisdom of science we will be deprived of "the only thing we need to handle these problems (food supply and environmental difficulties), an abundant and everlasting supply of cheap energy and it is readily available in nuclear reactors, including the breeder . . . Science and technology can provide not only for the 21st century, but for ever . . . I therefore find it difficult to share in the optimism that characterises this report."

One wonders whether Pittsburgh has heard of the experiences in the far-off state of Washington whose nuclear generation programme (acronymically known as "Whoops") has succeeded in quadrupling the cost of electricity, without notably increasing the output. ☐

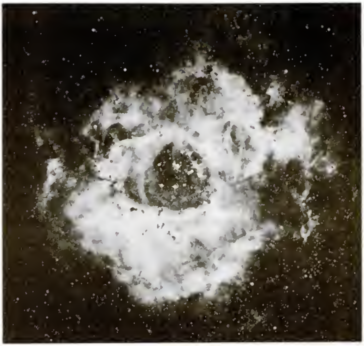
A many-splendoured thing

Atlas of Deep-Sky Splendours
by Hans Vehrenberg, *Cambridge UP, pp 242, £25*

Patrick Moore

HANS VEHRENBERG sets a high standard. His *Atlas of Deep-Sky Splendours* is a magnificent collection of the best available photographs of galaxies, nebulae and star-clusters, presented on a standard scale and accompanied by wide star fields to help in identification at the telescope. Over 400 objects are included, some photographed in colour, others in black and white. Sources range from the superb photographs taken at the Siding Spring Observatory in Australia, to Palomar plates and others taken at major observatories all over the world. They include some by Vehrenberg himself, whose reputation as an astronomical photographer is second to none.

Studying deep-sky objects is something which is not confined to the professional astronomer using elaborate equipment. Quite apart from the "classic" examples, such as the Orion Nebula, the Andromeda Spiral and the double cluster in Perseus, there are many others which are within the range of modest instruments. Identification can be a problem, and Vehrenberg has wisely provided finder charts. Of course, the delicate details and the colours cannot be seen at the eye-end of a normal telescope, but there are plenty of fascinating objects available.



The Rosette nebula

One of the great strengths of this atlas is that many of the photographs give a good impression of the actual telescopic view. And the instructions for locating the various objects are very good indeed. Consider, for example, the galaxy NGC 247 in Cetus. The text reads: "To find NGC 247, start from Beta Ceti (magnitude 2·2), swing the telescope 2¼ degrees southward, and wait 3½ minutes without moving the instrument. The motion of the Earth will carry the object into the centre of the field of view . . . Because of the galaxy's faintness, choose the eyepiece with the lowest magnifying power. The galaxy will then be seen as a pale oval spot without any structure." Nothing could be more explicit than this. I actually tried it, using a 15-inch reflector, and found that it worked very well, though admittedly the galaxy is very dim when observed with a telescope of this aperture.

The text is very clear and informative. It gives details of all the objects, together with their positions and dimensions. In many cases Vehrenberg has included the background to their discoveries, and descriptions of them by past observers such as Charles-Joseph Messier and Pierre Méchain.

It should not be thought that the book will be useful only to amateurs. It will be of equal value to professionals, and there is nothing else quite like it. The reproductions are first class; the print and presentation are impeccable, and by modern standards the price is very reasonable.

Adverse criticism is absent from this review simply because I can find nothing in the book to criticise: author and publisher are to be congratulated. This is a book which should be in the possession of every serious observer as well as in every astronomical library. There is an excellent index, which contains all the Messier objects and many others as well. For this fourth edition the whole text has been extensively revised and updated. No doubt there will be many more editions in the future. ☐

The awareness of animals

Animal Thinking
by Donald R. Griffin, *Harvard University Press, pp 237, £14·85*

Robin Dunbar

DONALD GRIFFIN has been at the forefront of a campaign to persuade the world at large (and behavioural biologists in particular) that attributing consciousness to animals is not a reprehensible lowering of scientific standards. His argument turns on the basic philosophical point that our knowledge of consciousness in fellow humans depends primarily on an argument by analogy. I know that I am conscious; I can see that other people behave in ways that indicate similar feelings and emotions to those I feel under analogous circumstances; moreover, they *say* that they experience those same emotions; therefore, it is reasonable to assume that they too are conscious.

As Griffin rightly points out, the basis on which we usually deny consciousness to animals is that they cannot tell us what they feel and think. It is a view that the behaviourists took to its logical conclusion in the 1930s by arguing that we ought not to ascribe consciousness or cognitive processes (like thinking) to any being, human or otherwise: science should limit itself to observable behaviour. It was a view that, perhaps luckily, physicists chose to ignore, or we might not have witnessed the flowering of quantum physics as we know it today. Ethologists, on the other hand, have been inclined to acquiesce in a behaviourist heritage, partly on the grounds that we ought not to attribute to animals more sophisticated mental abilities than are absolutely necessary to account for their behaviour, and partly on the grounds that the internal workings of the mind are too difficult to study in species that cannot tell us what they are thinking (if, indeed, they think at all).

Griffin wants to argue not only is this attitude presumptively dogmatic, but that the often tortuous lengths to which behavioural biologists go to avoid attributing consciousness to animals are counterproductive. Assuming conscious thought may provide a more parsimonious explanation for the evidently adaptive behaviour of many animals than the rather clumsy *ad hoc* motivational accounts offered by traditional ethologists (if they still exist).

Yet, when all is said and done, I remain unconvinced by the arguments that Griffin advances—not because I disagree with his thesis, but because none of his examples is sufficient on its own to provide the kind of rigorous proof that will convince the sceptical rearguard of behaviourism. They will rightly argue that perfectly sound adaptive explanations can be given for behaviour without it being necessary to invoke conscious thought processes. One of the problems is, I think, that Griffin seems to confuse proximate and ultimate explanations. The sceptics will want to know whether any of their explanations are inadequate if consciousness is left out of the equation, and the answer will by no means always be "yes" even if animals are conscious in the human sense.

My guess is that it will be in social behaviour that the most significant advances in our understanding of animal consciousness will emerge, for sociobiologists are already well on the way to it. In this area, it is often necessary for the observer to try to second-guess what his subjects are really up to, and assuming consciousness is an heuristically powerful solution to the difficulties involved. Significantly, perhaps, this is the one area that Griffin barely touches on.

Nonetheless, for those who remain sceptical, Griffin's challenge to conventional wisdom should provide at least some food for thought, though even I found his attribution of consciousness to insects hard to swallow (probably for purely dogmatic reasons). ☐

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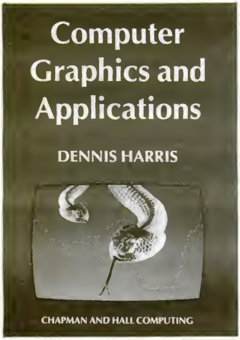

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Empire building and town planning

Religion and Empire
by Geoffrey W. Conrad & Arthur A. Demarest, *Cambridge UP, pp 266, £25*
Coba: A Classic Maya Metropolis
by W. J. Folan, E. R. Kintz & L. A. Fletcher, *Academic Press, pp 253, £50*

Nick Saunders

FOR THE PAST 15 years archaeology has been consolidating the gains made under the theoretical aegis of what is called the "new archaeology". One aspect of this has been the abandonment of research dealing solely with the unusual or dramatic—the lost cities, golden treasures and monumental sculptures. In its place the more mundane (but ultimately far more revealing) study of house forms, agricultural practices and settlement patterns has held centre stage, aided by advances in computer technology and the physical sciences.

Today, armed with the wealth of new data and conceptual models which are the real fruit of the new archaeology, anthropologists and archaeologists are looking at such topics as religion, politics and ideology in the hope of gaining an understanding of exactly how and why a particular prehistoric society followed a specific cultural trajectory.

The Aztecs made human sacrifices on a truly grand scale—and the conquistadors recorded the gory details (top, left and right)

An Aztec warrior had to capture the victims for sacrifice

Religion and Empire sets out to explain the role of ideology in the rise and fall of the Aztec and Inca empires. Conrad and Demarest see ideology as the cutting edge of imperialism and show how it is a dynamic element in cultural transformation. Both the Aztecs and the Incas manipulated ancient religious beliefs through new rituals, forming the basis of an ideology which itself shaped the state.

The Aztecs believed that it was their sacred duty to nourish their Sun god with human blood. This had the dual effect of guaranteeing the continued existence of the Universe and expanding the empire through warfare—which resulted in a continual flow of tribute and captives for sacrifice into their capital of Tenochtitlán. The imperial Incas instigated a "royal ancestor cult" that involved the practice of "split inheritance", whereby each dead emperor kept his palace, wealth and retainers. Each new emperor, though rich in privileges, was poor in personal wealth. He had to expand the territory of the empire in order to gain his own wealth, tribute and lands.

Both of these pre-Columbian empires were founded upon ideologies which successfully integrated politics with economics, religion and imperialism. And both were spectacularly successful in the initial stages of empire building. But, as easily conquerable land ran out, internal sociopolitical stresses began to tell. The ideology behind the system was incapable of changing to accommodate these stresses. Tied as it was to the religious validation of the hierarchical social system, the ideology became a serious liability to the internal stability of the two empires. Conrad and Demarest have done a great service to archaeology by producing a work that is compulsive reading, innovative and provoking in its assertions. It has marked out a new direction for archaeological and anthropological research.

Coba does not break new theoretical ground but it is an excellent example of what archaeologists in the early 1970s were calling "processual archaeology". Folan and his associates have undertaken the detailed mapping of an ancient Mayan city to gain a diachronic picture of urban development. The time-consuming and exhaustive mapping of households, their associated garden plots (called "solars") and the relationship between household/solar size and sophistication of the related architecture has provided a wealth of information which allowed the authors to trace Coba's history very accurately.

Coba flourished during the Late Classic Period of Mexican prehistory (about the 8th century). At this time it possessed some 20 000 structures, housing a population of perhaps 55 000 people. Its location in the northern part of the Yucatan peninsula was crucial, and an appreciation of this is necessary to understand the dynamic relationship between its size, form, function and development. Coba was the regional capital of a state of some 8000 square kilometres. It was located on the ecological demarcation line between the dry evergreen north and the tropical rain forest of the south and it was not far from the Caribbean coast. The city was located strategically for controlling the movements of raw materials and food resources and was also a production and trade centre, bringing in such necessities as obsidian and jade and pushing out cacao, honey and salt. The city itself had a continuous occupation area of some 70 square kilometres, divided into administrative, ceremonial, production and residential zones. The zones were linked by the famous Maya road system known as sacbeob (singular *sacbe*). *Coba* is a remarkable achievement, providing unique insights into the planning, building and functioning of a native American pre-industrial city. ☐

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Signposts to a more feminist science

Science and Gender
by Ruth Bleier, *Pergamon, pp 219, £16·50, £8·35 pbk*

Georgina Ferry

FEMINIST critiques of science (especially of the "science" of sex differences) often ruin their case by offering arguments as biased and little supported as those of the scientists they criticise. Ruth Bleier, herself a professor of neurophysiology, rarely falls into this trap.

Her "critique of biology and its theories on women" examines explanations for the almost universally subordinate position of women derived from sociobiology, neurophysiology, endocrinology, palaeontology, and anthropology. It concludes that biology has very little to do with it, and that patriarchy developed only gradually in association with the advance of civilisation. Bleier's style is cool and lucid, which does a great deal to enhance the essential reasonableness of her case.

Some passion does creep into her handling of the sociobiologists. They, perhaps inevitably given the recency of their influence and its political connotations, are the first in the firing line. Bleier demolishes them effectively, but I think is out of date in the importance she attaches to their more extreme pronouncements. Genetic determinism, at least with regard to human behaviour, is hardly mainstream thinking among biologists in 1984.

Bleier appears more comfortable in her own field of neurophysiology and in the influence of hormones on the brain. Here she demonstrates that the enormous degree of plasticity in the brain and the influence of environmental factors on its development and function are simply not compatible with sex-determined predispositions to one or another form of behaviour. Animal models of hormonal influences have proved inadequate to account for sex differences in behaviour.

Bleier moves on to palaeontology and anthropology to introduce persuasive alternatives to the "man the hunter" view of human evolution. These are based on the idea that gathering, rather than hunting, was the predominant form of subsistence among early human groups, an activity that in contemporary groups is the preserve of women. Societies developed on the basis of sharing the food thus gathered.

Fossil evidence suggests that the earliest settled communities were egalitarian in their organisation. It was not until villages combined into chiefdoms, city states and ultimately empires that dominance hierarchies developed, and with them the institutionalised subordination of women.

Bleier's valuable analysis of these early societies and contemporary anthropological evidence provides the best argument I have yet read that apparently "universal" gender differences are historical rather than biological. The only constant feature of male-female relations is that women can reproduce and be certain of their relatedness to their progeny, and men can do neither. From this derives the answer Bleier chooses to the question of women's subordination: institutions such as marriage were imposed by men in an effort to increase their certainty of their parentage and paternity. Whether the answer is right or not (there is probably no single right answer), the point is that change is possible; there need be no fear of flying in the face of nature in attempting to adjust the balance back in women's favour.

Bleier concludes with some signposts to a more feminist science, and thereby lands herself with a paradox. Scientists, she argues, need "what women, in general, have: the ability to listen and hear, to be aware and perceptive, to understand and appreciate process and interaction." This essentially *feminine* approach to science will ultimately, she believes, have repercussions that will lead to greater equality in society as a whole. However, the qualities she attributes to women are, as she herself admits, learnt as part of the socialisation of girls in a patriarchal society. Liberated from patriarchy, would these qualities endure?

Without waiting for feminist theorists to tie up all the loose ends, women are concerning themselves with science in larger and larger numbers. Bleier concludes that there is no need to lay down hard and fast rules about what is appropriate; she is confident that the greater participation of women means that, in time, "the contours of a feminist science will emerge". ☐

Crime under the microscope

TELEVISION

Bernard Dixon

IT'S AN ODD thought, but I would like to know how Dennis Skinner felt about **A Shred of Evidence** (Thames, 9 October), Liz Neeson's entertainingly instructive, and occasionally very messy account of work by the Metropolitan Police Forensic Science Laboratory. The Bolsover MP, you may have noted, distinguished himself recently by opining that policemen had been throwing bricks at each other and smashing their own vehicles to provide illicit evidence of picket line violence. If that argument is supposed to hang together, what sort of meaning could attach to the outcome of arcane and intricate investigations into the Libyan People's Bureau shooting last April?

Meticulously portrayed in this rare scientific excursion by Thames Television, those studies centred on whether shots had been fired from inside or outside the building. Examination of bullet fragments found in the street, in the ambulance taking WPC Fletcher to hospital, and in a wounded demonstrator provided clues about the weapon(s) they came from. More crucial still were results of a search just inside the bureau windows for traces of leftover primer residue from the cartridges. This contained antimony, potassium and chlorine—indicating that the primer had been an old, corrosive type. When the forensic team confirmed that the analysis matched that of chemical traces on the pieces of bullet, and even discovered a spent cartridge case, the conclusion seemed beyond dispute. "Suggestions that evidence had been planted after the Libyans left were accordingly disproved," asserted narrator Gordon Honeycombe. I tend to agree, though someone of Skinner's bent would surely find grounds to quibble.

Even the most ingenious critic of forensic scientists would have difficulty in challenging another gathering of evidence illustrated by the programme. In April last year a "hit and run" car killed a young woman in north London. Left on the roadway were part of a rubber bumper, fragments of a side light, and an indicator. Identified via the manufacturer's compendium, they revealed that the vehicle had been a Princess. Tiny flakes of red paint from the victim's clothes, analysed and then checked with British Leyland, showed that this particular combination of top coat and undercoat had been used between 1978 and 1980. But there were some 60 000 red cars, 600 of them in London, which fitted the bill. So police began a house-to-house search, and on the 15th visit found what they were seeking—a red Princess, with a new indicator and a hole in a bumper which corresponded precisely with the piece from the accident site. The only surprising aspect of *this* story was the sentence given to the killer—fines of £300 for not stopping and £75 for not reporting the accident, plus one year's disqualification from driving.

An excellent feature of Neeson's programme was the immediacy and economy with which she defined technical terms uttered by the boffins. No sooner had one white coat announced that a specimen was "prepared for the SEM" than Honeycombe explained the meaning and purpose of a scanning electron microscope. The commentary planted a few unanswered questions (what, for example, could the Barnstaple omnibus traveller have made of "rifling characteristics" or "a combined video camera and light spectrum"?). But in general the film sustained a high level of edification, whether surveying the seedy science of semen stains or telling the story of an apparent murder and house-wrecking where the blatantly obvious explanation proved untrue.

There was, presumably, public relations value here too. For this survey of pleasant people pursuing society's unpleasantries ended with a warning that the laboratory's staff had been cut by a fifth and its research halted. Well into the second term of a government committed to law and order, this is deeply perplexing. □

This week's contributors

William Clark is president of the International Institute for Environment and Development.
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Patrick Moore is presenter of *The Sky at Night* and author of many astronomy books.
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Steve Benbow/Network

Mexico, the city unlimited

This year Mexico City became the world's largest city, with 17 million people. No city has ever been so big or grown so fast. Demographers and planners are trying to catch up

Fred Pearce

IT TOOK London 130 years to grow from 1 million people to 8 million. Mexico City did it in 30 years from 1940 to 1970. London stopped at that point and began to shed its middle classes to the Home Counties. Mexico City had spent the past 15 years until today doubling in size again. It may double once more by 2000, though most estimates suggest that the city will grow by a mere 9 million by then. In the rapid rise of Third World cities, Mexico City is supreme. Calcutta and Rio de Janeiro, Bombay and Seoul are sluggish by comparison. Only São Paulo in Brazil is close to keeping pace.

Demographers are struggling to explain the rise of this new giant and to predict what will happen next. Planners want to make life better for the city's millions of poor and, at the same time, to keep new migrants away. They have yet to find a way of doing both.

Mexico City is a place of shanty towns sprouting TV aerials, of traffic jams and shops full of parts from wrecked cars, of huge armies of police and street vendors, of graft, political godfathers and the world's second largest national debt. The only thing that works properly seems to be the metro.

Even the Japanese (where Tokyo has been relegated to being the world's second largest city) could not improve on it. In fact the metro is about the only thing that keeps this chaotic, monstrous city functioning. The paradox is that it thereby allows the city to grow yet bigger.

The first fare-paying passenger rode the metro in 1969, when the city had a population of a mere 9 million. Now the growing underground network carries more than 3 million people a day, twice as many as London's underground on a system that is one-seventh the size. Despite rampant inflation that has multiplied other prices by 10 in 15 years, fares have stayed at one peso for any trip—about one-hundredth London's cheapest fare. You can fill a subway car in Mexico City for less than a dollar.

What you gain in cheap travel you lose in comfort. *Modern Railways* reported last month: "The theoretical capacity of a nine-car train is 1530, including 1170 standing, but up to 2800 people have been recorded on occasions". The crush continues all day, with the French-built trains travelling at strict 115-second intervals on the computer-controlled network. In perhaps 40 metro journeys recently I never waited longer than 3 minutes for a train, and never saw anybody risk wearing a suit down there. Suitcases are turned back by police patrolling the barriers.

Above ground is pandemonium. Altogether 20 million mechanised journeys are made in the city every day. Four million are taken by private car, 10 million on a fleet of 7000 battered and belching buses and the rest by metro and taxi. There are no surface railways for commuters. The central railway station is as large as Victoria or Grand Central, but only 17 trains leave every day.

City workers spend an average $2\frac{1}{2}$ hours every day travelling

Urban poverty is still better than rural poverty

Barry Lewis/Network

to and from work, even though few live outside the city limits. Average vehicle speed on the clogged roads is said to be 12 kilometres per hour, falling to 4 km/h at peak periods.

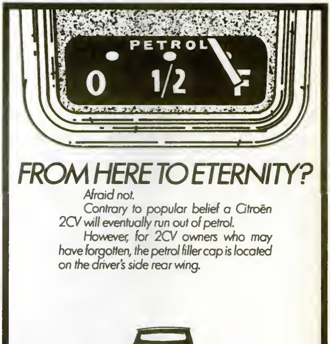
Vehicles are responsible for two-thirds of the pollution, which sends a thick smog across the city, reducing visibility to a couple of kilometres on most days. (It is not helped by the high altitude which results in greater carbon monoxide in exhausts.)

Much of this mad chaos of commuting should have been unnecessary. The problem is that the city grew up almost entirely unplanned and often outside the law. Most factories are in the north of the city, just over the border from the federal district, where rules are even more lax than in the city centre. Everybody lives miles from their work. Even on a Sunday the metro is packed as people from all over the city head for its one sizeable park at Chapultepec on the west side.

The huge majority of Mexico City's citizens are first- or second-generation migrants from the countryside. They began to arrive in the 1940s as the city's industrialists took advantage of the disruption in world trade caused by the Second World War to boost their business. The migrants fled the continuing poverty in the villages where land reforms in the 1920s and 1930s, which turned many vast privately owned haciendas into communal land, failed to bring prosperity.

In the years after the war, the socialist government based all its activities in the capital. Industrialists, anxious to win favour with ministers and officials, flooded in. Today 45 per cent of the country's domestic product is generated in the city and no fewer than 70 per cent of the banking transactions take place there.

Outside the capital, Mexico is an empty country with 37 people per square kilometre, one-sixth the population density of Britain. But Mexico City has around 17 000 people/km^2, four times that of London. Mexico City contains as many people as the whole of south-east England, from Dorset to



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Slums and skyscrapers: above, a squatters' encampment in Mexico City; below, the Latin American Tower

J. Messerschmidt/Camera Press

Ipswich, in an area two-thirds the size of Greater London. A typical slum settlement, the Sector Popular, has a density of 75 000/km^2, seven times the density of London's densest borough. Some 30 per cent of families live in one room.

For the foreigner arriving in Mexico City the city can seem horrific. Even *National Geographic*, an inveterately optimistic journal, calls it "an alarming giant". The smog is thick, blocking out the sun and frequently causing headaches; the local regard for basic hygiene, such as keeping cooked and raw meat apart, is minimal, making the revenge of Montezuma (the last Aztec ruler before the Spanish takeover) almost inevitable. The rats run and the rivers stink.

But whatever horrors there may be in Mexico City, the migrants go there because they believe life will be better than in the villages. One in 10 dwellings in the city lack a water supply, but in rural areas the figure is 5 in 10. Three in 10 homes in the city are not connected to a sewer against five in 10 in the country. One in 10 lack electricity compared with almost 7 in 10 in the villages. People are wealthier here and, despite the overcrowding and pollution, they live longer. Ten per cent of city dwellers are undernourished, against 90 per cent in rural areas.

The farms of Mexico have fallen into a crippling spiral of decline that leaves the country dependent on food imports. Food prices are held down for the benefit of city dwellers, so peasant farmers cannot make a decent living. Where irrigation projects have been started large landowners grab the best land. According to Antonio Martin del Campo, a professor at Mexico's National University, 4 per cent of landowners in irrigated districts control 37 per cent of the land. The small farmers are often denied credit to develop their farms. So they rent their land (which is not usually theirs but ceded under land reforms to them for their personal use) to the big estates. The land reforms at the heart of Mexico's revolution 60 years ago have fallen into disrepute.

Each day up to a thousand new migrants arrive at the main bus stations on the north and east side of Mexico City.

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It is only recently that demographers have attempted seriously to find out who these people are and exactly why they come. It turns out that they are not, as in many countries, young men arriving alone in the big city. Most will be joining relatives who have already made their home in one of the city's great slum suburbs—perhaps Netzahualcoyotl, near the airport, which has grown from nothing to home for about 2·5 million people in 25 years. More surprisingly, a majority of the new migrants will be young women, often very young.

A recent analysis of migration trends produced for the United Nations International Population Conference, which was held in Mexico City in August, produced this analysis of why young Mexican women take the bus to town: "During the last few decades it has become increasingly difficult for a family to support itself solely from the exploitation of its agricultural holdings. Therefore, a large proportion of the poor peasant population, as a survival strategy to complement the family's agricultural earnings, promotes its access to wage earnings by sending some of its members to urban areas . . . those most likely to migrate initially belong to the most easily dispensable labour force—which in the majority of cases is constituted mainly of young women."

Most of the newcomers work as maids in middle-class homes. The men who follow may work in factories or, increasingly as migration has overtaken economic expansion, as members of the anonymous army of shoe-shiners, and street vendors who line the streets of the city centre. But women and children (there are an estimated 100 000 economically active children in the city) make up a large proportion of the workforce—especially among the lowest paid. In a detailed study of one poor community in the 1960s, Oscar Lewis, author of *The Children of Sanchez*, found that women and children made up 76 per cent of the workforce.

Slums and social change

The migrants are far from from being no-hopers, reconciled to their lot, however. The UN report notes of Mexico City: "The marginality and poverty are often a passing stage for the recently arrived migrant, since his or her standard of living tends to improve throughout the active life." The continual stream of migrants take their place at the bottom of the social pile. One danger of stopping migration would be to halt this steady upward movement. And that could become a potent trigger for the civil unrest that many politicians in Mexico City fear.

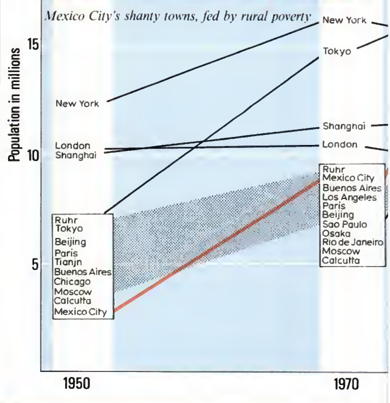
Netzahualcoyotl grew from a few shacks beside Lake Texcoco in 1959 (and nothing officially for a good few years after that) to a suburb with some 2·5 million people today. And it was there that the impetus for the government to bring services to these vast slums began in 1973 when a social revolt threatened to engulf the suburb.

In a city without proper local government, many services are provided only for communities that find the right political "godfather". As a result of these political shananigans, many communities are still without electricity (though they often hook up their own systems by splicing cable illegally into overhead cables). Peter Ward, a geographer at the University of London, says that "in one settlement, Santo Domingo, electricity posts lay idle on the ground for more than two years while different community leaders and their respective patrons disputed the costs and procedures of installation".

Such a system is clearly unfair and inefficient, putting political expediency above technological efficiency and leaving social justice a very poor third. But there are signs that patronage may be on the wane. Ward, who has made a special study of the development of the city's shanty towns, believes that, since the late 1970s, technocratic decisions have grown in importance. Large-scale engineering projects, such as the metro and a new deep drainage system, are less amenable to the more petty kinds of infighting. On the other hand, if the patronage system does break down, something must take its place as a method of local democratic control. Otherwise,

B. Lewis/Camera Press

Mexico City's shanty towns, fed by rural poverty



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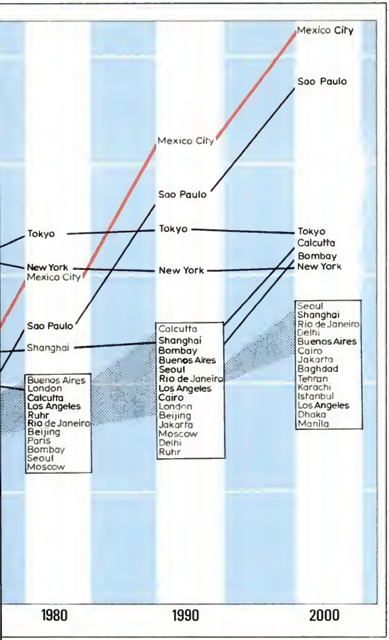

The age of the mega-cities: with the centres of population in the developed world marking time—and sometimes declining—Mexico City and Sao Paulo are witnessing explosive growth. Left: downtown Mexico City—only the metro runs on time

again, there could be trouble. The people might demand real representative democracy for the city.

But for now, says Ward: "The planning directorate does not command effective control . . . rather the mayor and his closest advisors tend to make critical decisions. . . . As far as a system of planning goes, however, Mexico is, as one high-level functionary put it, still in the dark ages."

So, while the city embarks on a vastly expensive scheme to increase its water supply by pumping water from more than 200 km away, its flush toilets guzzle 20 litres of water every time the chain is pulled (British toilets flush 9 litres and it is technically possible to do the necessary with 3·5 litres). The mayor is proud of having planted some 14 million trees in the last few years, one for every member of the population at the time, even though many of them are dying because air pollution is so bad. While the city desperately needs more parks and green open spaces (there is just half a square metre of green space per inhabitant compared with 25 m^2 in London), 18 per cent of the city's land is made up of vacant lots.

The police are notoriously overstaffed and corrupt. The last police chief is hiding out in Los Angeles after being accused of having 87 drug dealers tortured and murdered when they refused to pay him off. More mundanely, the telephone company is accused of arbitrarily adding extra calls onto phone bills. Disconnected phones are often billed for calls. Only the metro seems to run efficiently.

A. Sanderson/Camera Press

100 000 children go to work in Mexico City

Even if the city planners suddenly gained control of the reins of power they would face insuperable problems, however. Every extra metro station, every new water pipe and electricity supply line, every park, only encourages more people to come to the city and desert the already underpopulated countryside.

To put the process into reverse the government must stop spending money in the capital and start spending it in the villages. In theory, decentralisation has been the policy since the 1950s. But as recently as the late 1970s the state oil company Pemex was allowed to build a 52-storey office block in the city, even though all the oil is a thousand kilometres away. Almost everyone involved in the project now faces corruption charges. In 1980, in an attempt to reduce the attractions of the city, the government cut back on its public housing programme. By this year that policy had gone into reverse. The city chapter of the PRI, the ruling political party, promised a housing drive because it said it feared political unrest.

Since Mexico's economic crisis in 1982, when it came within an hour of running out of foreign credit, many industrial workers have seen big cuts in their wages. The union bosses, who dominate the PRI, are now pushing for improvements. But Mexico's great ununionised underclass, the peasants of the countryside and the street vendors in the cities, who were poorer to start with and have suffered more, have no power base from which to fight back. And no state safety net to protect even their most basic needs. Malnutrition, if not outright starvation, is rife in the countryside of Mexico today. Twenty million people are undernourished. It is this rural poverty which is, and has been for 40 years, the main reason why the country's peasants flock to cities, and especially to Mexico City. They do not expect the streets to be paved with gold, but they will find most of them paved. They do not expect wealth but they do expect to find a place on the bottom rung of the state's ladder. They hope to step from the Third World to the First World.

It is the great irony of Mexico's revolution, which began in the early years of the century, in the abject poverty of the landless workers on the haciendas, that its beneficiaries have been the city-dwellers. The revolutionary PRI has failed to eliminate the big estates and failed to invest in the countryside and in the peasants who made its revolution. And until that betrayal is ended Mexico City will continue to grow, an extraordinary symbol of the power of free enterprise in an allegedly socialist state. ☐

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IENCE

Physical Constants – Planck, electron mass, electron charge, Rydberg, Gravitation, Avogadro, speed of light, sound. Gas constant, permeability, permittivity, earth radius, Bohr radius, Astronomic unit, etc.

Conversion Factors – UK to MKS etc.

Formulae – LC circuit, Lenses, Bohr energy levels, Larmor, plasma, etc.

Integration Under a Curve

Least Square Fit

Solution of Polynomial Equations

ILITY

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MATHEMATICS

Bessel	– functions
Polynomials	– solutions of equations
Matrices	– solution of matrix equations Eigenvalues
Integration	– under a curve
Curve-fitting	– least squares
Statistics	– mean standard deviation Chi-squared

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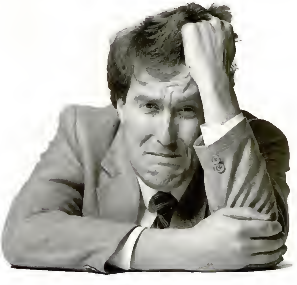

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Thinking for tomorrow

Preparing the past for the future

Those relics of past cultures that survive to tell us about their creators need a little help from science to carry on their tales. Spectroscopic analyses of these objects occasionally tell the conservation scientists a thing or two in return

Don Robins

D. W. Lee

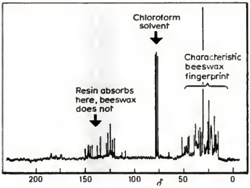
OUR RESPLENDENT heritage often seems to engulf the present with a vast array of objects—antiques of all shapes and sizes, historical artefacts, fossilised material, monuments, buildings and machines—all stranded by the inexorable tide of history. These relics, which may come from the remotest antiquity or where recent history fades into nostalgia, will rarely survive their journey into the future unaided. They need the attentions of conservation science to return them to some semblance of their original state.

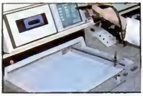
Those outside conservation may wonder at the relevance of science to its activities. In fact, an exchange of information is involved through which the scientist may learn as much as the conservator. The general emphasis of conservation science is on materials, which makes it an aspect of the wider field of material science. Conservation science is mainly preoccupied with identifying materials from the past, determining the extent and mechanisms of their decay, and assessing conservation, storage and display treatments. When science or, at least, common sense is not applied to conservation, horror stories can and do happen. Take the case of the careless conservator who wouldn't own up, for example. One sherd of an important Meso-American pot was cleaned without testing and the delicate slip decoration was scrubbed off. Rather than assemble the complete pot with one damaged sherd, the conservator chose to remove the decoration from all the remaining sherds. The reassembled vessel looked like undecorated earthware. Then there is the strange tale of the darkened cathedral. When resin was applied to a large portion

1: Nuclear magnetic resonance

PRO

Nuclear magnetic resonance details every carbon atom in a molecule, so it can "fingerprint" organic mixtures such as are found in medieval seals (left). NMR depends on the absorption of radio frequency energy by nucleii when influenced by a strong magnetic field. The most useful for organic compounds is ^{13}C. The nucleii's electronic environment influences energy absorption: these differences can be shown as spectra





Glaxo

NMR spectrum (above) of the royal seal of William IV. The resin and beeswax date the seal approximately. An NMR spectroscope (right)

Imperial War Museum

Conservation equals science plus object. The science is up to date but the object may be tens of years old, such as Concorde; as indestructible as a Conqueror tank; unique and fragile like the Sistine Chapel; centuries old, such as the 5th century BC Greek helmet; or an industrial relic, such as the Beyer-Garrett loco

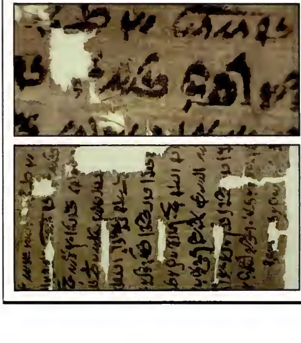
Michael Holford

of stained glass in the building, it drastically reduced the transmitted light and turned the once bright and beautiful colours dull and lifeless. The resin, used for many years to coat street signs, was considered to be safe, durable and strong. No one thought to test it systematically on glass beforehand, let alone test it on a small portion of the window.

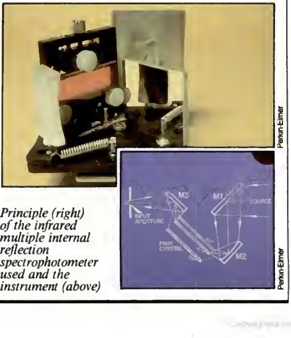
Another horror that appears occasionally concerns the hasty or inexperienced cleaning of bronzes, especially from archaeological sites. The result is unsightly pitting or removal of the original surface preserved in the corrosion layers. Unethical conservators have been known to disguise the damage with tinted wax and green paint, which often set up zones of accelerated corrosion.

These three tales demonstrate how conservation can benefit from scientific methods and analysis. And promotion of good conservation science will be the aim of the new research and development centre that has just been set up by Camberwell School of Arts and Crafts (see Box 4). An example of how science can benefit from conservation—this time in the area of industrial archaeology—arrived in Plymouth from South Africa a few weeks ago. It is a 28-metre-long wheel-base

2: Infrared spectroscopy



Infrared radiation causes molecular vibrations: stretching and bending. Inorganic molecules are less responsive to infrared than organic. Spectra obtained from both sides of Egyptian papyrus (left) found in mask cartonnage, revealed a characteristic weakening in the chain ether bond, the main structural unit of cellulose



Perkin-Elmer

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Principle (right) of the infrared multiple internal reflection spectrophotometer used and the instrument (above)

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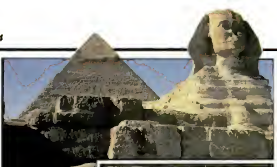
Michael Holford

Conservation of an object may be tailored to a unique object, such as the threads in this 15th century Flemish tapestry or the Sphinx at Giza (right and below right). Analysis of a material from a specific period, such as nitocellulose plastics (left), may provide widely applicable information



G V. Robins

Michael Holford

Beyer-Garratt steam locomotive (which is 7 centimetres longer, due to heat expansion, under a full head of steam). Conserving the engine will be a major engineering undertaking which might more properly be called "restoration", because the objective is to return it to its original condition. The British passion for the preservation of steam locomotives is a manifestation of a wider interaction between laboratory techniques and conserving large objects, including buildings. The quest for perfect restoration often involves the cannibalisation of similar machines or the custom-building of components to create one perfect specimen, usually at exorbitant cost. Since the great interest is working steam, effort does not finish with the recreation of a perfect specimen: wear and tear create maintenance problems far and above those arising from deterioration on static display.

The possibility of monitoring deterioration in use has arisen with the arrival in Britain of the 195-tonne Beyer-Garratt in working order. 4160 Ltd of Plymouth took delivery of the locomotive from South African Railways, and is ready to resume the engines's working life in South Devon. With the owners' agreement we shall use analytical techniques such as X-ray fluorescence to monitor wear. The idea is to reduce maintenance by predicting wear and deterioration before they become serious.

As with steam locomotives, preserved aircraft often come with a complete and detailed history, so storage or maintenance in relation to display or use pose great problems. If we know an object's precise original condition, how do we preserve it so? With aircraft such as Concorde, of which two examples are static exhibits, the past catches up dramatically with the present.

3: Electron spin resonance

Engraved bone (left) from Derbyshire 35 000–8000 BC, and (right) a medieval, ivory book cover. ESR relies on the effect of microwave radiation on unpaired electrons, produced by burning, in a molecule. An unpaired electron will "spin flip" in the presence of a strong magnetic field. ESR can establish the presence of burning in ivory: infrared methods reveal other causes of discoloration

ESR machine (below) at the Laboratory for Analysis and Safeguarding of Antiques at QMC, London

Photographs Michael Holford/inset Ed. Barber

The rigorous development of Concorde ensured that all stages of its life are exhaustively documented. An external static display is obviously liable to corrosion and weathering, because the environment cannot be controlled (there may not much more possibility of controlling the environment in a large hangar, however), but it seems a truism that the better the original condition of the machine the easier its care will be. Nevertheless, attention to the paintwork, and treatment of exposed or vulnerable metalwork with lacquer or corrosion inhibitors, point to the impact that science can have through the development of new and more effective conservation materials even where the present requirements for treatments are minimal. Science also learns from the process.

The main area where science interacts with conservation is not in engineering or the environment, it is in analysis. Any form of analysis, however, requires a sample, and analyses of complex materials normally encountered in conservation often require reference samples, ancient and modern, when absolute analysis is neither possible nor necessary.

Analysis and sampling are inextricably linked; each conditions the other. Access to capital equipment conditions the analyst's approach considerably and may lead the analyst to accept only a narrow range of problems. But whatever the approach, sample acquisition is the fundamental step. It is unlikely that the owners or custodians of *objets d'art* and national treasures will agree to the breaking of chunks or fragments from their charges for analysis, however worthwhile or important the result.

Because many analytical techniques depend upon the dissolution or vaporisation of the sample (generally analysis is more precise when molecular interactions in the solid state are minimised by dissolution), the nature of many composite materials under conservation means that lower-precision solid-state analyses must be undertaken. Just because a method is nondestructive, however, does not mean to say that the sample is recoverable. Although there is always some concern over how representative a small fragment of an artefact may be, this can be lessened by a well-considered choice of both old and new reference samples.

Science Museum/M. Holford

No woodworm, and good for 200 years more: Arkwright's water-frame spinning machine, 1769

D. Robins

She'll need care but . . .

Recent analyses of fragments cover a wide range of artefacts and problems: mediaeval royal "wax" seals which were crumbling and flaking; used Egyptian papyrus recovered as *cartonnage* from mummy cases (where it was used like newspaper in papier-mâché) in a very fragmentary state; ivory carvings with discoloration thought to be due to burning; and early nitrocellulose plastics, made into "art deco" objects as imitations of materials such as ivory and tortoiseshell. Each of these objects presented a similar problem: the original material and its deterioration products had to be identified for conservation treatment to be successful. Such identification went beyond the scope of visual or microscopic inspection.

While the fragments were all expendable, the problems of analytical strategy were difficult. Dissolution techniques were inappropriate to papyrus, and while it is possible to dissolve nitrocellulose the necessary solvents might well destroy the evidence required. Similarly, the dissolution of ivory is virtually impossible without chemical attack. The medieval seals presented the simplest problem, because they normally contain a wax/resin mixture with an inorganic pigment.

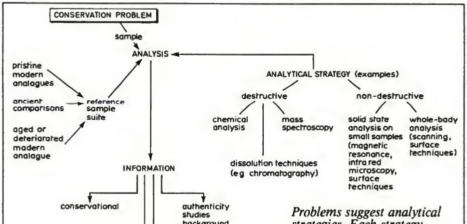
Although organic solvents (such as chloroform) would dissolve out the organic components, it took a joint project to solve the riddle of how to conserve the range of medieval and recent seal fragments (see Box 1). The Public Records Office provided the seals, NMR spectroscopic facilities came from Glaxo Group Research and together we showed, by comparison with reference waxes and resins, that the medieval seals contained only beeswax and that later seals contained waxes and resins, usually pine tree colophony.

4: A new centre for conservation research

MORE THAN £70 000 of public money has been provided to fund the new Centre for Research and Development in Conservation Science in London's Camberwell School of Arts and Crafts. Its director will be Don Robins who sees the new venture as a focus for conservation research in the United Kingdom as well as overseas.

The centre's aim will be to develop the "overall range of knowledge and understanding in the subject and to assist in meeting national conservation needs." It will do this by providing information, education and scientific support programmes.

One of the first tasks will be to set up the basis of a data bank on conservation practices, materials procedures and developments. Once the information has been evaluated then it will be made generally available. Later, the centre will become involved in research into the properties of artefacts and of materials relating to conservation.


CONSERVATION PROBLEM
sample
ANALYSIS
pristine modern analogues
ancient comparisons
aged or deteriorated modern analogue
reference sample suite
ANALYTICAL STRATEGY (examples)
destructive
non-destructive
chemical analysis
mass spectroscopy
dissolution techniques (eg chromatography)
solid state analysis on small samples (magnetic resonance, infra red microscopy, surface techniques
whole-body analysis (scanning, surface techniques)
INFORMATION
conservational
authenticity studies background
archaeological/technological
general or specific contribution to materials or analytical science

Problems suggest analytical strategies. Each strategy generates different information. What path should the conservation scientist choose?

The methods of identification and analysis adopted in the programme will be, as far as possible, "state of the art" in scientific instrumentation. Programme results will be disseminated internationally.

A third stroke of effort from the new centre will be to run seminars and meetings for people and organisations involved in conservation. This activity will include preparing and supervising courses prepared specifically for individual groups. ☐

D. Robins

It also became clear that the choice of waxes and resins, after the medieval period, seemed to correlate with the discovery of other materials as the ages of exploration opened the wider world to Europe. Deterioration in the seals was only minimally due to chemistry; most of the structural change was due to slow, physical changes in crystallinity caused by temperature changes or loss of small amounts of volatile material. The presence of copper or mercury-based pigments kept microbiological attacks to a minimum.

Investigation of the nitrocellulose plastics required an infrared technique, with equipment from Perkin-Elmer, which could be applied directly upon the plastics. The materials' spectra showed almost no dependence upon their physical state: pristine, modern nitrocellulose was identical to the most embrittled, crazed and discoloured early sample.

While we anticipated (reasonably, we thought) chemical attack on the cellulose from free nitric acid, which certainly attacked the metallic containers, the infrared analysis gradually uncovered a physical rather than a chemical phenomenon, and this was eventually traced to camphor. Camphor was as an early plasticiser (a material added to polymer to enhance plasticity, aid fabrication and reduce later development of brittleness) and unlike modern plasticisers is extremely volatile. Because it was added in substantial quantities, its subsequent evaporation left "holes" around which the remaining nitrocellulose crystallised and set up structural stresses.

Infrared spectroscopy also lent itself to the direct examination of the papyrus fragments from a study of cartonnage by a student at the Institute of Archaeology, University of London, (see Box 2). Infrared light was transmitted through the material and in the surface technique of Multiple Internal Reflection (MIR), which could look at both sides of the papyrus independently. Written papyrus, widely encountered in museums, forms an enormously important link with antiquity. Whether recovered from cartonnage or direct excavation, its state of preservation varies enormously: lack of care and conservation can allow deteriorated papyri to crumble to dust.

Modern papyrus shows a distinctive cellulosic spectrum which differs from deteriorated, ancient samples where the main structural unit in cellulose – the chain ether bond – is weakened. A linear, polymer cellulose might be expected to fragment along its axis (via the break of inter-chain hydrogen bonds) and while this does occur, it seems to be accompanied by a break across the axis at the linking units. Such destabilisation obviously creates chemically altered groupings and reactivity, and such information is useful in choosing an appropriate conservation treatment.

Solid-state infrared spectroscopy was used in conjunction with electron spin resonance (ESR) spectroscopy to study burnt ivory from Nimrud in Iraq (see Box 3). The presence of burning can be established by the measurement of a free-electron species (radial carbon, C') which is ESR-active and produced by burning. Discoloration by other means, for example absorption of metal salts, can be distinguished by this method. Simultaneously, infrared analysis established the amount of ivory broken down to the ivory protein and provided evidence of chemical modification that will influence conservation treatments.

These examples reflect my background in spectroscopy and the adaptation of some techniques to solid materials. Nevertheless, they highlight a striking feature, namely that chemical deterioration may not be the most important factor. Even when this is important, it may be possible to detect it readily by simple physico-chemical means. For example, measuring the acidity developed by paper is an exercise in *p*H determination, which can be done with dry samples and an appropriate electrode. Similarly, the value of a microscope and hand lens in identification of visual features (such as fibre characterisation) is not to be dismissed lightly. The criterion remains the type and nature of the information required rather than any excuse for a scientific *tour de force.*

The "destructive" methods of testing are important in some areas of conservation science, particularly when vanishingly small samples are required. Pre-eminent among these techniques are the chromatographic and mass-spectrometric "families". Based upon obtaining information through separation, they work well on complex mixtures amenable to solubility and volatility. They can be used singly or as coupled analytical systems, as in GCMS (gas chromatography-mass spectrometry). The National Gallery in London is in the forefront in developing these techniques to examine paintings where the layers of paint decay in complex patterns and their mixtures vary significantly between masters and schools. The scope for this type of analysis to authenticate painting is significant.

Many varnish and lacquers polymerise over long periods and are not readily amenable to techniques that depend upon dissolution. One way to avoid this problem is to precede chromatographic or mass spectrometric analysis with a sampling step that produces smaller molecular fragments. A preliminary technique that is exciting some interest is pyrolysis, where flash heating in the absence of oxygen (thermal cracking) produces molecular fragments that have complex thermodynamic relationships with their polymeric precursors. Pyrolysis-GC and -MS have both been introduced in conservation science, and a recent collaboration with Cadbury-Schweppes in pyrolysis-MS is being developed into a substantial programme on insoluble lacquer-type materials.

Inorganic materials pose fewer problems of identification than organic materials (the metals or metallic ions generally remain throughout rusting and corrosion) and a whole range of surface inorganic techniques are available for their detection. The challenges with many metallic materials are different: for example, the structure of a rusted sword blade can be explored through a crumbling scabbard with radiography. Chemical analysis, with its inherently destructive nature and relatively large sample demand, has a minor place in conservation science. However, the potential of microchemical techniques and microscopic "spot tests" has been largely ignored because the present instrumental and physico-chemical emphasis has made them unfashionable. Nevertheless, conservation practices and laboratories operating on small budgets (if they operate on a budget at all) could find immense profit from investigating this high-water mark of the analyst's skills which has effectively been buried under the avalanche of instrumental techniques. □

Don Robins is reader in conservation at Camberwell School of Arts and Crafts

. . . he'll need leaving alone

D. Robins

Evolution and the giraffe's neck

Critics of NeoDarwinism too hastily conclude that natural selection cannot account for many of the evolutionary changes in the morphology of animals

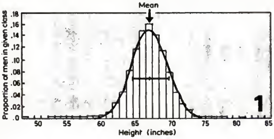
Brian Charlesworth

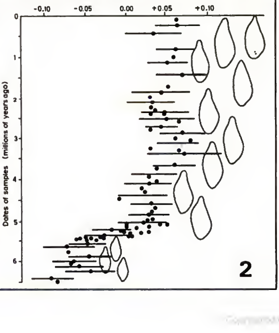
NATURAL selection is often thought of as merely providing a plausible explanation of evolution, rather than a rigorously established scientific theory. Critics of NeoDarwinism, such as Stephen Jay Gould of Harvard University, have caricatured selectionist explanations of particular structural (that is, morphological) or behavioural traits as "Just-so-Stories", and indeed it is all too easy to concoct untestable evolutionary scenarios to explain the elephant's trunk and the camel's hump. Although natural selection provides the only mechanistically credible explanation of the obviously adaptive nature of many features of living organisms, it is only reasonable to ask for more direct evidence. But alternatives to natural selection, such as the theory of molecular drive recently proposed by Gabriel Dover of Cambridge University (*New Scientist*, 9 December 1982, p 664), cannot explain the morphological changes that animals have undergone during evolution. I argue that morphological characteristics normally display enough genetic variability for selection to be effective in producing rapid evolutionary change, and, furthermore, that natural selection does indeed act on such characters.

H. Goldstein

Do we need new explanations to account for the giraffe's extraordinary neck, or is modern Darwinian theory enough?

Many of the characters used by biologists to distinguish species alive today, or to study evolutionary change in fossil lineages, can be expressed as measurements of the sizes and proportions of bodily parts. For example, one of the most striking evolutionary changes in the well-documented fossil record of horses is an increase in the height of the grinding teeth relative to their width. Such characters typically vary considerably within populations of modern organisms (Figure 1). Following the pioneering work of George Gaylord Simpson in the 1940s and 50s, palaeontologists have collected extensive data on such variability in fossil specimens. The amount of variability in these ancient populations is similar to that in comparable modern samples and is often remarkably constant over long periods of time, even when the mean of the character changes considerably (Figure 2).





Animals of a given species vary in size and shape: the distribution of height among English soldiers in 1939 fits a bell-shaped curve (above). This variability can remain stable over time, even as the population evolves, as shown by a single-celled marine organism, Globorotulia *(right). The dots show the mean shape of its skeleton, the bars the standard deviation*

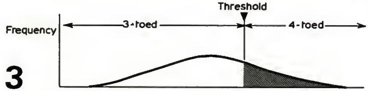
Investigations of the genetics of such continually varying characters in modern populations have shown that a high proportion of the variability (typically between 15 and 75 per cent) is due to genetic rather than environmental factors, and hence can lead to evolutionary change by selection. Furthermore, there is usually no simple genetic basis for this variability; instead, several genes, located at widely different positions in the chromosomes, seem to contribute to the variation in a single character within a single population. The fact that many genes, as well as the environment, often influence a given trait explains the continuous nature of much morphological variation.

There are, of course, numerous morphological characters of an all-or-nothing kind, or which fall into several distinct classes, such as the presence or absence of a foramen (hole) in a skull bone or the number of digits on a limb. Many such characters show variation in both modern and fossil populations. Genetic studies, going back to the pioneering work of Sewall Wright on guinea pigs in the 1920s, have shown that variation in a discrete character is usually due to the effects of several genes that cause variation on an underlying continuous scale (Figure 3). Such variation can thus be handled statistically in much the same way as continuously varying characters.

These facts tell us that selection for an increase or decrease in a character can be expected to make rapid progress without having to wait for new mutations to occur (although mutation is the ultimate source of all genetic variation). Numerous experiments on artificial selection have confirmed this, but the intense selection pressure and the small population sizes used in most experiments usually lead to a cessation of response after 30 generations or so, due to the loss of genetic variability. Experiments that create a moderate pressure of selection in larger populations show a more or less indefinitely sustained response to continued selection

(Figure 4). William Hill, working at Edinburgh University, has recently shown that these long-term responses to selection can be explained quantitavely in terms of a balance between the generation of new variation by mutation and the exhaustion of variation by selection. The rates of change in the mean of the population in these experiments are more than a thousand-fold greater than the rates of change observed in even rapidly evolving fossil lineages. There is, therefore, no difficulty in understanding the fact that substantial evolutionary change can take place without depleting variability (Figure 2).

I now turn to the question of whether or not natural selection can actually be shown to act on morphological characteristics. The most informative method of answering this question is to compare the rates of survival or the reproductive success of individuals with different values of the character. This approach does not require any prior knowledge of the functional significance of the character, which in many cases is unknown. A less informative, but easier, method is to compare the mean and variability of the character in samples taken before and after selection is presumed to have taken place. This method has even been successfully applied, by Leigh Van Valen of Chicago University and Björn Kurten of Helsinki University, to fossil populations of horses, bears and antelopes where material has been recovered from groups of individuals which were fossilised at different ages: the older individuals represent a group which has been exposed to selection on their ability to survive.



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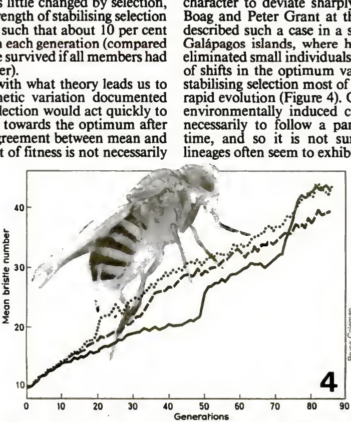
Michael Lutch/NOVA

Guinea pigs never have three and a half toes: they normally have three, but sometimes four. But, as Sewall Wright showed, the "leap" is due to the effects of several genes that cause variation on an underlying continuous scale

It is usually found that intermediates are at a selective advantage compared with extreme (*stabilising* selection), so that the mean of the character is little changed by selection, but variability is reduced. The strength of stabilising selection on a single character is typically such that about 10 per cent of the population is eliminated in each generation (compared with the number who would have survived if all members had the optimal value of the character).

This finding is in agreement with what theory leads us to expect: given the extent of genetic variation documented above, calculations show that selection would act quickly to push the population mean back towards the optimum after any deviation from it. A strict agreement between mean and optimum for a single component of fitness is not necessarily expected, because the course of selection is controlled by net reproductive fitness—the reproductive success of an individual over its lifetime—and the same character could have different effects on different aspects of fitness. In view of this, it is remarkable how many examples of purely stabilising selection have been reported in the literature.

An important difficulty in interpreting evidence of this kind was pointed out many years ago by Alan Robertson of Edinburgh University. He suggested that the genes controlling variation in a given character might have effects on fitness that are not directly related to their effects on the character itself, but act in such a way that genetically intermediate individuals have superior fitness. Apparent stabilising selection may not necessarily reflect selection on the character itself. One of the few experimental tests of this has been carried out in my laboratory by Kevin Fowler. He used special breeding techniques to create flies that were all genetically identical, but differed in bristle number as a result of environmental factors or accidents of development. He found that flies with intermediate numbers of bristle still had the highest mating success, which obviously cannot be due to side effects of bristle genes, but reflects selection on bristle number itself (or a character developmentally related to it).



Bruce Coleman

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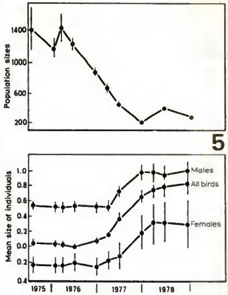
Three groups of fruit flies, subjected to moderate selection for increased numbers of bristles on the abdomen, show a more less indefinitely-sustained response to continued selection

Strong selection for a changed mean has sometimes been detected. Such selection is usually due to a sudden environmental change which causes the optimum value of the character to deviate sharply from the current mean. Peter Boag and Peter Grant at the University of Michigan have described such a case in a species of Darwin's finch on the Galápagos islands, where high mortality due to a drought eliminated small individuals (Figure 5). It is clear that a series of shifts in the optimum value of a character that is under stabilising selection most of the time can lead to geologically rapid evolution (Figure 4). One would not, of course, expect environmentally induced changes in a selective optimum necessarily to follow a particularly constant pattern over time, and so it is not surprising that well-studied fossil lineages often seem to exhibit irregular fluctuations in mean, with occasional periods of accelerated evolution in one direction (Figure 2).

It is, of course, a gross oversimplification to speak of selection as acting on a simple character in isolation. Genetic studies causes variation in a range of other, developmentally related characters. Selection on one character can, therefore, result in an evolutionary change in another, correlated character which is not itself subject to selection. For example, Russell Lande working at the University of Chicago has shown how changes in brain weight in mammalian lineages could be explained purely as a by-product of selection on the genetically correlated character, body weight. Furthermore, the effect of one character on fitness may be dependent on the state of another; an increase in the size of teeth, for example, might be advantageous in large individuals, but disadvantageous in small ones. Lande and his colleague, Stevan Arnold, have recently developed statistical methods to analyse the effects of natural selection on a set of different but correlated characters. When they applied their methods to data on a natural population of pentatomid (shield) bugs, which had suffered high mortality due to a storm, they found that selection on one character could completely mask the effect of selection on a correlated character. For instance, selection for a larger thorax was counteracted by selection for smaller wings because individuals with large wings tended also to have large thoraxes.



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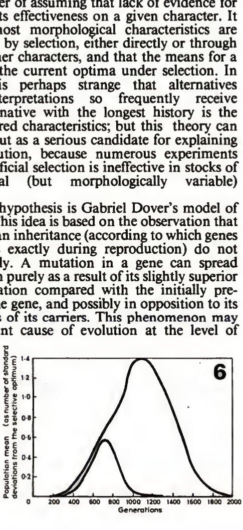
A drought on the Galápagos islands in 1977 caused huge mortality in the finch Geospiza fortis, *particularly among smaller individuals. The result was a marked increase in the mean size of the finches*

M. P. Harris/Bruce Coleman

These facts bring out the subtlety of the possible effects of natural selection of morphological characters, and emphasises the danger of assuming that lack of evidence for selection disproves its effectiveness on a given character. It seems clear that most morphological characteristics are significantly affected by selection, either directly or through correlations with other characters, and that the means for a character evolve to the current optima under selection. In view of this, it is perhaps strange that alternatives to selectionist interpretations so frequently receive attention. The alternative with the longest history is the inheritance of acquired characteristics; but this theory can definitely be ruled out as a serious candidate for explaining morphological evolution, because numerous experiments have shown that artificial selection is ineffective in stocks of genetically identical (but morphologically variable) individuals.

A better-founded hypothesis is Gabriel Dover's model of "molecular drive". This idea is based on the observation that the rules of Mendelian inheritance (according to which genes replicate themselves exactly during reproduction) do not always hold precisely. A mutation in a gene can spread through a population purely as a result of its slightly superior power of self-replication compared with the initially predominant form of the gene, and possibly in opposition to its effects on the fitness of its carriers. This phenomenon may well be an important cause of evolution at the level of sequences of DNA which have little effect on fitness, but Dover proposes that characters such as the giraffe's neck could evolve in the same way. He suggests that a character might be controlled by a "family" of related genes (with each individual possessing many copies of the family), such as are known to control the production of ribosomal RNA and other cellular constituents produced in large quantities. A mutation with an advantage in self-replication, which arises in just one member of the family in one individual, could spread through the population, and eventually come to occupy all members of the family in each individual. It could thus produce a noticeable effect on the character in question, even though the presence of one copy of the mutant gene in an individual would have little effect.

In computer simulation a character soon returns to the optimum (0) when 2·5 per cent (upper curve) or 25 per cent (lower curve) of the variation is due to genes not under "molecular drive"



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Leaving aside the difficult question of how frequently morphological characters are in fact controlled by gene families of this sort, Dover's argument runs foul of the evidence presented above. Most morphological characters that have been studied seem to be close to a selective optimum; this would not be expected if molecular drive had overcome the effects of selection. If molecular drive were powerful enough to fix a given mutation in opposition to selection, selection would use the abundant variability contributed from other sources to restore the mean to the optimum (Figure 6). Furthermore, morphological adaptations involve the mutual adjustment of many different components, for example, a change in neck length requires changes in blood vessels, nerves, muscle attachments and so on, not just an increase in the size of vertebrae. It is inconceivable that such coordinated changes could be brought about by molecular drive, since there is no reason to expect any relation between the self-replicatory powers of mutations and their effects on the characters concerned. The most it could achieve would be a succession of small oscillations in the character means. As far as morphological evolution is concerned, there is no alternative to natural selection. ☐

Dr Brian Charlesworth lectures in the School of Biological Sciences at the University of Sussex.

FORUM

How the media abuse heroin

Libertarian myths about drug addiction are dangerous, argue John Strang and Les Kay

CHANNEL 4 nearly made a good programme about heroin last month *A Bad Habit,* 26 September). *New Scientist's* preview of the programme nearly produced a good article, (20 September, p 10).

Both failed for the same reason. The first part of the programme and the article did a valuable job in stripping away some of the mystique which surrounds heroin. Even though there are casualties, and its use seems to generate or contribute to many problems, heroin is still just a drug like many others with good qualities as well as hazards. The shock-horror approach of the media has itself contributed to these problems.

The programme showed—for almost the first time—the acceptable face of heroin use. Not all people who take heroin are "junkies". Heroin can be used safely, and has a valuable role in the management of severe pain. Surprisingly, its use in this way does not lead to addiction even though administered regularly. What is more, it may even be taken recreationally without inevitably leading to squalor and degradation.

Where the producer and writer both slipped up was in allowing their libertarian tendencies to run away with them. Instead of getting behind the media myths and explaining how and why problems can develop, they ended up reinforcing one of the most enduring myths of all, that of the "disease of addiction".

Junkies aren't wicked, they are ill, was the message they left us. Because they are ill, the answer of course is medical treatment. Addiction as a disease requires replacement therapy, just as does diabetes. Diabetics need injections of insulin; drug addicts need injections of heroin. If only doctors would make heroin freely available on prescription, the problem would go away.

This argument is an old and discredited one. It was first promoted in Britain in 1926 when Lord Rolleston advanced the "disease" model of addiction as a counter to contemporary theories of drug abuse as a "vicious indulgence". It led to the so-called "British system" of maintenance prescriptions.

In order to dress up this old chestnut in new clothes, the programme asserted that maintenance prescribing had been abandoned in 1968 when the drug clinics were set up. This is completely untrue. Part of the initial brief of the clinics was precisely to provide legitimate supplies of the drugs in controlled settings and so entice "diseased" addicts into a therapeutic relationship.

For at least the first few years of the clinics, they prescribed just such large amounts of injectable heroin or similar drugs on open-ended maintenance programmes.

The truth is that the system failed. If users had regular and clean supplies of the drug of their choice, why should they stop? It was like suggesting that a suitable treatment for problem drinkers would be the provision on the National Health Service of daily bottles of vodka.

Probably the most foolish blunder the programme made was its assertion that not only would maintenance prescribing help individual users, but it would also eliminate the black market in drugs. Anyone who believes this cannot have thought the problem through.

The message from former heroin user Pete Townshend is that the drug is not *"safe"*

In order to destroy the black market, heroin would have to be available legitimately on the National Health Service to *anyone* who wanted it. This would mean making it freely available to every recreational user, every 16-year-old who fancied a dabble with heroin.

If you didn't make heroin so freely available you would still have a black market for those, presumably non-dependent, users who could not get a supply from the doctor. This would be even worse. Those physically dependent could get pure heroin free. Recreational users would have to pay for their heroin on the black market. It does not take much imagination to see that this system would actively encourage recreational users to become daily dependent users in order to save money!

The proposal to extend maintenance prescription as a way of eliminating the black market is as dangerous as it is foolish. What is more, a glaring contradiction lurks beneath this muddled libertarianism. The programme presented us with a case study of a woman who obviously found life to be one long round of threatening situations. She needed heroin, she told us, because it gave her a second skin to protect her from a hostile world.

We suspect that if the same woman had been using prescribed tranquilisers she would have been portrayed in a different way. She would have been held up as a prime example of the irresponsibility of doctors deluding their patients into thinking they had a medical answer to social and emotional problems. The use of drugs creates problems that are too pressing and too complex to be given this sort of glib treatment.

With heroin, a choice exists—not just for the drug-taker but for society. By and large, specialists have rejected a single disease model. Instead, drug abuse is seen as a more complex sociological phenomenon to which there are particular medical aspects and complications.

Doctors in Britain still have the right to prescribe almost any drug, if they believe it appropriate. The vast majority of them direct their attention to providing help for people to stop their drug-taking.

How bizarre it is at a time when the medical profession is rightly under criticism for its prescribing practices with drugs such as Valium, that there should also be criticism about their failure to prescribe other mood-changing drugs. The critics seem to be arguing both ends against the middle. In abusing the drugs issue in this way, they do not help society to understand and to respond to the problem. □

Dr John Strang and Les Kay work at the North West Regional Drug Dependence Unit, Prestwich Hospital, Manchester.

Cracking the problem of oiling the wheels

Martin Sherwood looks at the life of Friedrich Bergius, whose coal-to-oil process helped fuel the Second World War

BRITAIN'S coal strike has lasted so long only because of the relative unimportance of coal as an energy source. If we had remained a coal-based economy, a settlement would have had to be reached long before now. This would have been particularly true if coal rather than oil were our main source of liquid fuel—a situation which might have arisen had the Nobel prizewinning chemist Friedrich Bergius achieved his aim.

Bergius, born 100 years ago this month, devised the high-pressure process for converting coal into energy liquids, which helped to keep both Hitler's Third Reich and the Royal Air Force mobile during the early 1940s. But the process he developed was limited to situations in which normal market forces were suspended. His other major contribution to technology, the development of high-protein foods from waste cellulose, suffered the same drawback. Yet, with recurrent scares about world energy and food shortages, both areas still attract funds, which scientists use to build on the foundations Bergius laid.

Mary Evans

Bergius turned coal into oil

Bergius was born on 11 October 1884, at Goldschmieden, near Breslau (now Wroclaw in Poland). His father owned a chemical factory and, from early youth, Friedrich showed an interest in technology. He studied chemistry at Breslau University, then moved to Leipzig, where he obtained a doctorate in 1907. He then worked with Walther Nernst in Berlin and Fritz Haber at Karlsruhe. It was Haber, inventor of the high-pressure process for ammonia manufacture, who interested Bergius in the use of high pressures and high temperatures to bring about difficult reactions.

This, together with his own interest in the origins of coal, led Bergius to study coal hydrogenation. A major difference between coal and crude oil is the carbon-hydrogen ratio. Coal is closer to being pure carbon, which is why it is solid rather than liquid. By hydrogenating coal, it might be possible to produce imitation oil.

After a brief spell as an academic at Hanover, Bergius became head of the laboratory of Goldschmidt AG at Essen in 1914. For the next 13 years, he developed his experimental hydrogenation of coal, which he had patented in 1913, into a commercial process for liquid-fuel production. By 1922, he had a plant operating at Rheinau, near Mannheim, with a throughput of 1 tonne per day, using hydrogen at 100 atmospheres pressure and a temperature of 400° C. This gave a yield of 25 per cent petrol and 40 per cent oil. Soon after this Bergius turned his attention elsewhere. However, the process was developed further by the German chemical giant, IC Farban, which improved both the catalysts used and the operating procedures. As a result, by 1936, a single plant at Leuna was producing more than 250 000 tonnes of motor fuel per year, while three other German plants brought total production to over 600 000 tonnes a year. By 1938 capacity had risen to 1·4 million tonnes a year, and this nearly trebled during the Second World War.

It was not only the Germans who benefited from Bergius's invention. On 15 October 1935, ICI at Billingham opened a plant capable of producing well over 100 000 tonnes a year of motor fuel from coal and coal tar. ICI's involvement in this field had not been without incident. Even at that time, such processes were uncompetitive with imported oil and the government had refused to offer satisfactory subsidies. Consequently, at one point, ICI, which had bought the Empire rights to Bergius's invention in 1927, reduced its R&D staff on the project dramatically. As a result, a young organic chemist, Eric Fawcett, was sent to work on a completely different high-pressure project, and unintentionally discovered polythene (*New Scientist*, 24 March 1983, p 837).

By the time he was awarded the Nobel Prize for Chemistry in 1931, Bergius was concerned with a completely different project, the conversion of wood into edible material. This research was financed partly by Scotch whisky distillers. They lost faith in the research, however, and control of the process later went to the Nazi government for a pittance.

Bergius's process used hydrochloric acid to break down cellulose to sugars which could then be fed to yeast. It thus provided a source of edible carbohydrate or protein, and was used by the Germans during the war. After the war, the occupying Americans refused Bergius permission to restart the process. As a result, he left Germany, moving first to Spain and then to Argentina, where he was a technical adviser to the combustible fuels section of the Ministry of Industry. He died in Buenos Aires at the end of March 1949. ☐

Martin Sherwood works in the pharmaceutical industry

Land of the rising daughter

Gail Vines sees hope for the future in an unusual Japanese businesswoman

JAPANESE BUSINESSMEN are not famed for their liberated attitude to women. Yet one woman, at least, has convinced entrepreneurs there and abroad that she has something important to say. From Tokyo, Momoko Ito runs the Japanese subsidiary, as well as the international operations, of an American company known as Energy Conversion Devices, Inc. Her success is due, I suspect, to the way she has married her remarkable personal dynamism to a technology company with good ideas.

Energy Conversion Devices (ECD) is a business with a mission—to creat new technologies that can efficiently convert solar energy into electricity. The company's chairman is Stan Ovskinsky, a polymath engineer who became convinced that amorphous materials, rather than crystals, could be used to make new and better photovoltaic devices (among other things). Consigned to the lunatic fringe for years, he has at last become accepted by the scientific community.

Ovskinsky's openmindedness and intuitive feel for a fruitful, if unconventional, approach are perhaps nowhere more evident than in Ito's own rise to fame. He recruited her to the company 12 years ago, when she was an eminently capable but bored housewife with a degree in linguistics. As a Japanese national living in the US, Ito was not only bilingual, but bicultural as well; she could mediate between two very different cultures. She went off to negotiate a host of deals with Japanese businessmen and now heads ECD's Japanese subsidiary.

She attributes much of her success in the Japanese business world to having been brought up by "two very powerful women"—her mother and grandmother. "It never occurred to me to be intimidated by men. Once a woman has that confidence, even Japanese men respond."

But she believes that most women have a flair for managing people and solving problems, which makes the recruitment of women scientists and engineers even more urgent. "Women have a uniqueness that is needed for the world," Ito argues. "Whether their special abilities spring from biology or culture is immaterial. Perhaps the male and female cultures will eventually merge. But now women have unique things on offer—flexibility, practicality and a special ability to establish priorities immediately." Ito sees these qualities as essential to the search for solutions to the crisis that fast approaches: new sources of energy when coal, oil and even uranium are depleted.

The mother of two teenage children, Ito has not always found it easy to combine home and work. But she is a missionary. "If I have any source of strength, it is because of my commitment to the company." It is difficult to come away unconvinced that Stan Ovskinsky and his colleagues are not on to something that might just save the world. ☐

Do you believe in magic?

Things that go bump in the night fail to frighten Roy Herbert

OVER THE YEARS, I have learned to avoid certain subjects and certain people, developing an instinct for recognising danger signals and dodging. This is a refinement of the tactics needed to get through a bus journey without catching the eye of the drunk who wants everybody to join him in a chorus of "Danny boy". I can now tell with pleasing accuracy when to leave the room when the ghost story is about to surface. "The doorknob turned. I watched it. I didn't know what to do. And when I finally opened the door and looked, there was nobody there." Or "He appeared in full uniform on the stairs and that was the exact moment when he died." I have had both these anecdotes repeated to me at various times and I am always embarrassed and at a loss about what to say in response. Scepticism is, or may be, wounding and I have no wish to wound friends, or anyone else. So I keep silent or ask if everybody would like coffee.

The UFO eccentrics are a different matter and sometimes skate on the edge of madness. Working in a government office, I once had my door slammed open against the wall by a wild-eyed colleague. I had made some mild remarks about UFOs and the application of Occam's Razor to the subject, in reporting a lecture by Professor R.V. Jones, who had illustrated its application in graphic terms. The door-slammer pounded my desk. Raging, he shouted, "I'm the expert on unidentified flying objects. You want to say anything about them, you ask me. You hear?" He then charged out, not forgetting to slam the door in the opposite direction. I found that he was a member of the British UFO Research Association, at that time half-inclined to believe in flying saucers hovering for days above tropical islands while carrying out repairs and signalling to a local priest on the ground who had thought to take out a torch for Morse code inquiries, though not a camera. Or his camera had mildew.

Having developed, I thought, foolproof and failsafe behaviour against such situations, I was proved utterly wrong over a lunch table a few days ago, caught out in mid-pudding. There were no warning signals at all, simply a conversational log across the road to drive headlong into. "Our fridge," said a guest, "works without being connected."

Frozen in the act of wielding spoon and fork, I recognised that it was too early to offer coffee all round and that I was in for it. According to the story, the fridge in question had been disconnected, plug out of the wall socket, when the motor began to work. The fridge was not near any other electrical equipment. "How did you know it was running?" I asked. "Of course it was running, I could hear it making that noise." "You're telling me that a fridge motor not connected to an electricity supply, started up on its own?" "Well, it did." This is tricky ground. The guests were far from impressed at statements that electric motors ran on electric power and wouldn't run if there was none, implying that I was a credulous idiot if I took that line. Having surmised, lips pursed and eyes at the ceiling, that it might be something to do with static electricity, one guest, triumphantly playing the decisive card, said. "Well then, *you* tell *us* how it worked!". This was clearly thought to be the *coup de grâce*. The conversation moved on.

What fascinates me to the point of desperation, is that my guests were all of more than average intelligence, half of them university graduates. Yet they wanted to believe an impossibility, that an electric motor, working on alternating current of 50 cycles per second at 240 volts, could start up and work when disconnected from the supply. They *preferred* to believe this rather than any feasible explanation or that they were wrong or misled. They wanted, in truth, to believe in magic.

I do not know why and I wish I did. ☐

Astrophysics in Liège

William McCrea salutes the achievements of two great scientists

THE 25th Liège International Astrophysical Colloquium, in July this year, was dedicated to Professor Paul Ledoux in celebration of his 70th birthday. It was also a salutation to him on his retirement (under university regulations) some months earlier, which inevitably denoted the end of a chapter in the distinguished history of a remarkable institution. Some of the most important developments in modern astrophysics have had their origin in the Astrophysical Institute of the University of Liège; many leading astrophysicists owe a great debt to the stimulus of time spent there.

In the years preceding the Second World War the institute was headed by Marcel Dehalu, a very influential individual in the university and a shrewd judge of talented young men. In the years since the war it has owed its status predominantly to outstanding leadership given by two of these, Pol Swings (1906-1983) and Paul Ledoux.

Swings became a full professor in 1932 and began to build up his spectroscopic laboratory in the institute, working chiefly on problems of astrophysical importance but also on numerous other applications. Molecular astrophysics has made such tremendous advances in recent years, with more than a score of different molecules identified in clouds of gas and dust between the stars, that it is salutary to recall that the first discovery of an interstellar molecule was made nearly half a century ago, in 1937. It was made by Swings and Leon Rosenfeld, in Liège. Swings was the father, Liège the cradle, of molecular astrophysics; it has grown up to enjoy a lusty prime.

On the outbreak of war in 1939, Swings was stranded in Yerkes Observatory in the US where he had gone to resume a fruitful collaboration with the famous observer Otto Struve (1897-1963), and Ledoux was stranded in Oslo. In due course, Swings participated in the American technological war effort. In 1940, by making a barely credible journey through Sweden, the USSR and Siberia, Ledoux marvellously contrived also to reach Yerkes. But in 1941 he got himself across the Atlantic to join Belgian armed forces in Britain; he served here and in the Belgian Congo until 1946.

After the war, back in Liège, Swings, Ledoux and the institute went from strength to strength. The institute had come to participate in the European Southern Observatory, to lead Belgium's part in space research, and to collaborate with the Observatory of Haute Provence in installing in 1970 a French-Belgian Schmidt telescope. Swings was president of the International Astronomical Union during 1964-67, and presided in 1967 over its general assembly in Prague. In 1949 he launched the famed Liège Colloquia; one has been held yearly since then, save when a larger international activity supervenes.

Ledoux: astrophysical pioneer

Ledoux has done for theoretical astrophysics in the institute what Swings did on the laboratory and observational side.

Besides those of Swings and Ledoux, at least two other names should be mentioned: Boris Rosen, who did so much for the laboratory of molecular spectroscopy, and Marcel Migeotte, who developed solar observations in the infrared from the Jungfraujoch and from balloons, with the study of telluric absorption as a by-line.

These scientists have inspired a new generation of workers in whose hands the future of their institute is in safe keeping. ☐

William McCrea is professor emeritus in the Astronomy Centre at the University of Sussex.

Pesticides, windpower and telephone taps

More technical issues for Westminster

THISTLE DIARY

Tam Dalyell MP

I LEARN on reliable authority, that the government will introduce legislation in the next session of parliament on pesticides. The form of words contemplated is "to control the supply and use of pesticides in the UK with a view to protecting the health of humans, animals, and plants; having regard to the environment generally; and with a view to securing the efficient use of pesticides."

In terms truncated to the point of simplicity, such a bill would give statutory force to the Pesticides Safety Precaution Scheme of the Ministry of Agriculture, Fisheries and Food. This scheme has been voluntary since its introduction in 1957. However, as I understand it the proposed bill will not cover aerial crop-spraying, which continues to harm both wildlife and people. Nor will it help to control the export of pesticides to developing countries, where 375 000 people, it is claimed by sources within the United Nations, are poisoned each year by the misuse of pesticides. The minister says that the proposed legislation will replace the present dual clearance and approval systems with one overall approval scheme.

THIS HURTS ME MORE THAN IT HURTS YOU!
INSECTICIDE

The shame is that the opportunity has not been taken to review and to improve the standards of pesticide testing, and therefore to promote the protection of both users and the environment in particular. I am concerned that all products presently cleared but not approved—that is not being defined as "efficacious"—will be deemed approved products. Anyone with views on this topic ought to speak now or forever hold their peace.

* * *

UNRESERVEDLY, I welcome the decision of the Department of Energy to approve the construction of a windmill, at the cost of £10·5 million, to generate power for householders in the Orkney Islands. I understand that it will be capable of supplying all the power needs of over 1000 houses there—one of the most windswept parts of Britain. The machine will have two blades, each measuring some 200 feet (60 metres) across. By July 1986, it should be producing some 3 megawatts of power per hour, replacing the diesel generators, which have long supplied Orcadians. At first, the cost estimate is 10 p/kWh, compared with 6 p for oil-generated power. The North of Scotland Hydro Board hopes that once the technology has been proved, and production models have been built, costs could fall to 3 p/kWh.

I do hope the new windmill has none of the jinxes of the Danish one, near Aarhus: everything there seems to have gone awry. For one specific reason I am particularly glad to see the Orkney development, and hope that the people of Skara Brae do not put their jinx on it. If conservationists see what little contribution the biggest and the best windmill can make, they might become less strident in criticising civil nuclear power. Too often, windmills are trotted out as a way round the awkwardness of nuclear power.

* * *

TELEPHONE TAPPING is a vexatious subject. In the fight against crime, such as drug pushing, it is justified. Yet where does one draw the line? Technically, it is not difficult to tap a telephone without the knowledge even of regional telecommunications engineers. Yet, it is one thing for a Home Secretary to authorise telephone tapping through a publicly owned corporation such as the old Post Office Telephones of British Telecom. It is a very different matter to allow telephone tapping through a private concern. Has this problem been thought through before British Telecom becomes privatised? □

Better bred than dead

David Challinor on the efforts of zoos to preserve rare species

ZOO DIRECTORS and others concerned with the survival and well-being of zoo animals are increasingly interested in the ability of wild animals to adapt to captivity. The present design of new zoo exhibits reflects in part this concern. Not only are the new barless enclosures more aesthetically pleasing to the visitor, but they are also designed to reduce some of the neurotic behaviour shown by some mammals, particularly primates and cats, when confined to the old fashioned menagerie cage. The moats and glass barriers now used are designed to protect the animal from the visitor and, in the case of glass panels in primate houses, serve the double purpose of keeping the monkeys from catching humans' colds and freeing the visitor from the animals' pungent smell.

Despite such improvements, some zoo-bred animals, when moved from cramped quarters to landscaped habitats, cannot readily adapt. We have had several examples of animals' difficulty in breaking habitual behaviour at the Smithsonian National Zoo. Our white tiger, Mohini, released from her old barred cage to expansive new quarters with trees, grass and even a swimming pool, seldom strayed from her electrically heated concrete pad. She even wore out the grass walking back and forth in front of it, covering exactly the distance she had travelled during her years in her old quarters. Eventually, after a few months, she was able to break this pattern and occupy the entire enclosure. Yet, one of our polar bears, when moved to large new quarters, was unable to swim freely in his new pool, paddling in a tight circle of the same diameter as of his old pool.

The most recent anecdote about animal adaptation to new conditions comes from the Rio de Janiero Primate Center, where a colony of captive golden lion tamarins was removed from small enclosures to a very large outdoor one to start training them for ultimate release to the wild. Old males in their new enclosure would climb only along the stable wooden framework and supporting cables. The flexible natural branches were too much for these old males, but not for the younger animals in the troops, who readily adapted to their new surroundings.

Although some animals are adapting well to captivity, unexpected problems continually arise. The magnificent sable antelope is now breeding successfully at the Smithsonian's Conservation Research Center at Front Royal, Virginia. However, their hooves are not worn down as fast in the lush pastures and hardwood thickets of Virginia as they are in the flinty soils of their home ranges. Unless manually trimmed about twice a year, their excessive length can damage the muscles and small bones in their feet. Trimming is done while the antelope in tranquillised by a dart gun. Unfortunately, sable antelope seem to be more vulnerable than other antelope species to darting, with the result that we have lost some animals by using this method. The challenge is now to find other ways to keep their hooves the proper length.

Grass is better than concrete

If hoof trimming of sable antelope is still awaiting solution, other problems have been easily solved. For example, newborn scimitar-horned oryx are very susceptible to frost if born in cold weather. The problem was resolved by simply removing the breeding males from our herd for about four months each year to ensure all births would occur when it was warm. ▶

David Challinor is Assistant Secretary for Science at the Smithsonian Institution, Washington DC.

As our knowledge of the physiology of captive wild birds and animals increases, so does our success in maintaining them in zoos. Impressive results have now been achieved in establishing breeding colonies of penguin species, many different primates, and even such difficult captive breeders as peregrine falcons. Such recent breeding successes have encouraged plans to assemble survivors of scattered local populations of such rare mammals as the Sumatran two-horned rhinoceros in a last-ditch effort to keep them from becoming extinct in the wild.

Our recent successes have encouraged us to take the drastic step of capturing rare wild animals for captive propagation, for we have the sad history behind us of the last quagga, the last passenger pigeon and probably the last Tasmanian wolf all dying in zoos.

Even though some of the very rare species now being captured may never be returned to the wild, I still believe it is worth all the effort spent today to keep them in existence. ☐

ENIGMA

No. 279

Tall Stories

by Susan Denham

I'VE just been talking to four interesting sisters. I asked the youngest how old she was. She whispered the answer to the tallest sister who whispered the answer to Anita who told me the answer was 53. I was a bit surprised and so I assumed that one of those three must have made a mistake. So I asked the eldest how old she was. She whispered the answer to Barbara who whispered the answer to the shortest who told me the answer was 26! Had these three made a mistake?

Charlotte then explained to me that although all four of them knew their facts and did their calculations correctly, before stating a number they always changed it. One of the sisters always doubled her numbers, one always added 1, one always reversed the digits, and one always squared her numbers and deleted the left-hand digit of that square.

The second eldest sister said she'd help. She asked the eldest and youngest their ages (and the eldest's answer *was* the larger of the two) and she calculated the difference and told me what it was: I happened to know that this was also her age.

Then the youngest whispered her age to Davina who whispered it to the second tallest who told me.

What number did she tell me?

A £10 book token will be awarded to the sender of the first correct solution opened on Thursday, 1 November 1984. Please send entries to Enigma No 279, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1 1NG. The Editor's decision is final. The winner of Enigma No 276, "Wrong Figures to Add", was John Burnham of Worthing.

Answer to Enigma 276

Wrong figures to add

2791
7643
2991
8593
22 018

FEEDBACK

SPIFFING is not what you think. It is the trade name for the unsavoury practice of giving cash rewards to shop assistants in return for their pushing a particular product. Pity the poor customer who asks a shop for advice when the staff have a product to spiff.

The hi-fi press named names a few years ago and stamped out the nasty practice. Now Philips, the Dutch firm with a super-clean image, appears to be playing a similar game with video recorders.

Philips has stopped its advertising agency making fun of the company's name in the famous "Firrips" commercials. Now it promises people who work in retail shops a voucher worth £4 (tax-paid) for every Philips recorder they sell before 31 December 1984. That's on top of a gaggle of other incentives, such as giving sales staff the chance to draw lots for bigger prizes and a free holiday.

The £4 vouchers can be cashed in at W. H. Smith, Peter Dominic, Dewhurst the butcher, Thomas Cook Travel and Burton. So if you see a well-dressed, well-fed, sunburnt sales team, be on your guard if they recommend Philips. ☐

ELECTRONICS companies get used to having their gadgets stolen during public exhibitions. Ferguson recently lost a hi-fi system which was set up the night before a press conference.

Last week, though, Sony hit the jackpot. The company lost a prototype of its pocket-size compact disc player *during* a press conference at the Churchill Hotel in London. One minute, the press were playing with the device, one of only four made. Then some food and drink arrived, and the player was gone.

Sony's people are now wondering whether the first scoop review of this extraordinary little gadet will appear in a catering magazine or the hi-fi press. ☐

A WORD of warning for anyone plotting a similar heist. Don't try to gain access by re-using one of the sticky badges that security officers hand to visitors of posh companies and to journalists in hotels with expensive cutlery. The badge may rumble an unauthorised wearer by turning blue.

The badge does not have polygraphical qualities. It simply deteriorates in bright sunlight, so that anyone who has left the building since being given a badge is easily detectable. According to Tempbadge of New Jersey, companies in the US such as General Electric have joined organisations such as the FBI, Congress and the State Department in issuing self-destruct badges to visitors.

Feedback last week tested a sample Tempbadge in London's October sunlight. It worked. But would-be spies might like to know that a photocopy of the self-destructed badge is legible and definitely not blue. ☐

A RARE chance to sound off about WISE (it stands for Women Into Science and Engineering) next week. The minister for information technology and a group of MPs will answer questions at a seminar at the Institution of Mechanical Engineers, London, on 31 October. Registration begins at 9.15 am. ☐

WHICH is more important: shady, bountiful trees or access to sunlight? Ask Rudolph Sher, an engineering professor, and P. Herbert Leiderman, a psychiatry professor, and you will get markedly different answers. Ask them both at the same time and you're liable to get into a fight.

Sher and Leiderman are neighbours on choice land that California's Stanford University set aside to house its tenured staff. The two have been feuding for more than 13 years. Now the disagreement has reached the courts. There, it may set some important legal precedents about residential access to sunlight.

Both families built houses at Stanford in the early 1960s. The Leidermans planted a row of some two dozen redwoods, pines and acacias. There was no problem for 10 years or so until the Shers asked that the tops of the trees be lopped off. That kept the peace for a while, but now the Shers say that their "once warm, cheerful and sunny house has become cold, dark and depressing".

The Shers claim the trees are a "public nuisance" under the recently passed California Solar Shade Act. They are suing their neighbours for $50 000 in damages.

The Leidermans retort that the Shers' house was not built as a solar house as defined by the act. Each side accuses the other of intransigence.

The building industry, advocates of solar power and of course the legal profession are watching the case closely. Even in litigious California, cases involving squabbling neighbours rarely reach the high courts. ☐

IT'S NOT EASY to feel sorry for someone who has just won a Nobel prize. But think of all the fuss that goes with the £150 000 (or less if you have to share it).

For a start, the first the winner hears about the prize is a seemingly endless series of phone calls from journalists. The calls begin a few minutes after the prize is announced in Stockholm—even if the winner lives in California and has to be called in the middle of the night.

This is partly a result of the Nobel committee's watertight construction. Unlike most national governments and international organisations, the committee *never* leaks information in advance. So journalists, deprived of a civilised source of information, have to play a furious game of "hunt the prize-winner". The vital thing is to talk to the laureatte before he or she tires of all the attention, and leaves the phone off the hook.

Ahead of the field last Monday was Lawrence McGinty, the ebullient science correspondent of Channel 4 News, and former news editor of *New Scientist*.

Breathless with excitement, McGinty broke the news to Cesar Milstein's secretary at the molecular biology laboratory in Cambridge. "Oh, no, not again," was the rather deflating reply. For the same secretary had worked for Frederick Sanger when he won his second prize for chemistry in 1980, and knew too well all the fuss that ensues. ☐

LETTERS

Data heaps

In the past large amounts of material have been dug up and metal extracted from those small parts of it that made economic sense at the time. The remainder was designated waste. Subsequently, improved technology and the rising cost of metals has meant that it made economic sense to extract metal from these "wastes".

Scientific enquiry might be likened to the above in that experiments are carried out and those nuggets of information extracted that seem valuable at the time. The remaining information is relegated to the equivalent of a data slag heap. The nuggets of information are processed by the scientific press, and from time to time recycled, but unlike the ore slag heaps the data slag heaps are usually lost for ever. With the increasing scope for data storage, and bearing in mind the ever rising cost of experimentation, perhaps now is the time consider forming a data slag heap. Only one is needed! A latter-day reseacher (possibly a computer with nothing better to do!) might then sift through this slag heap and produce its own intellectual gems.

B. Longson
Leigh
Lancashire

Distortion

Ivor Williams (6 September, p 18) obviously objects to a distorted map of Britain being shown on TV. In the article by John Gribbin, "Meteorology blows hot and cold", to which his is an accompaniment, appears a graph which is misleading to about the same extent: that of the atmospheric CO_2 build-up in Hawaii.

In graphs with scales having natural zeroes which are "off the page" it is good practice to show a break in the axis (or axes) to draw attention to this to avoid accidental misinterpretation.

In the present case a quick glance suggests that atmospheric CO_2 concentration has rocketed since 1958: it has indeed increased, but by about 15 per cent, which is less exciting.

Graphs and indeed other presentations in *New Scientist* are typically rather carefully thought out—but vigilance seems still to be necessary.

R. M. Loynes
Sheffield

Latin flagellation

Simon Goodman's article on the cytoskeleton was good on science but poor on Latin plurals. In common with most of my students, he uses the incorrect plural *flagellae* for *flagellum*—the correct plural is, of course, *flagella*! Unfortunately, students believe what they read in your magazine, so please try to get it right next time.

P.E. Smith
North East London Polytechnic
London

Vets in industry

The committee of the Association of Veterinarians in Industry has been contacted by a number of members who have expressed concern at some of the contents of the article "Antibiotics breed lethal food poisoning" (This Week, 13 September, p 3).

The article appears to be a denigration of our profession generally, as exemplified by the caption to the first photograph, "A needle in the behind makes cattle fat and humans deadly sick". It is, incidentally, difficult to understand the relevance of such a photograph in an article primarily concerned with antibiotics in feed.

Our members are particularly incensed by the comment "When is a vet not a vet . . . when he or she is working for a drug company". Although the statement is qualified by "say some people", it is clearly derogatory to veterinarians in the pharmaceutical industry.

We dispute your suggestion with reference to pharmaceutical companies that "drug firms employ vets as 'consultants' to provide farmers with prescriptions for antibiotic feed additives". The Association of Veterinarians in Industry is strongly opposed to excessive or indiscriminate usage of therapeutic, ie prescription only, antibiotics in feed, and indeed we have made representations to the relevant authorities encouraging stricter control of the use of antibiotics in such situations: some of these recommendations have been incorporated into the Animal Health and Welfare Act, 1984.

The 1984 Guide to Professional Conduct of the Royal College of Veterinary Surgeons, with which we are in full agreement, contains two statements relevant in this context. The first, with reference to a veterinary surgeon's right to prescribe, is: "It is always necessary to approach with great care the prescription or supply of a medicinal product for a species not named on the data sheet, particularly if the prescription or supply is for food producing animals." This is because different species may metabolise the same drug in different ways: the drug may be toxic in an unlicensed species and drug residues may remain in edible tissues for longer periods.

The second guideline, with reference to "animals under his care", requires that a veterinary surgeon should have the animals, for which medicines are to be prescribed, under his/her regular, day-to-day supervision. This clearly means that a veterinary surgeon employed by a pharmaceutical company is precluded from writing prescriptions for animals not under his care. To do so would be to break the law.

In addition to expressing opinions about antibiotic resistance, particularly with reference to *Salmonella* spp., with which we disagree, your article infers that veterinarians employed by reputable pharmaceutical companies are interested only in maximising sales without any attention to ethical or safety considerations and this, we suggest, is both unwarranted and untrue. Such an article in a publication which purports to be scientific, as its name suggests, is unbalanced and grossly misleading.

The Association of Veterinarians in Industry therefore respectfully demands that your reporters substantiate their allegations concerning veterinarians employed by the pharmaceutical industry or unreservedly withdraw them.

David Ross
Vice Chairman
Association of Veterinarians in Industry
Great Chishill
Hertfordshire

British Isles

If Mr Larkin (Letters, 4 October, p 54) is touchy about the fact that Cork is located within the British Isles, it's no use complaining to *New Scientist*.

He can be reassured that there is no suggestion that the British Isles are in the ownership of the government of the UK, just as the Irish Sea is not managed from Dublin.

G. A. Royle
St Helens
Lancashire

GRIMBLEDON DOWN

Bill Tidy

IS THIS REALLY 200 TONS OF PRIME EEC BEEF?
YES. THEY'RE KEEPING IT ON ICE TILL THEY CAN THINK OF SOMETHING TO DO WITH IT. COULD BE YEARS!
SOUNDS EMINENTLY SENSIBLE TO ME. CAN ANYTHING BE DONE, MR. ROWLEY?
IT'S MADNESS! I'M TRYING TO CREATE ARTIFICIAL PROTEIN NUFOOD FOR THE HUNGRY, AND THIS IS SITTING HERE! TREEM, I COULD TURN THIS 200 TONS INTO 1000 TONS OF NUTRITIOUS FOOD!
I DON'T SEE WHY NOT, AND WE COULD STORE IT OVER THERE!

ONE BOMB DOESN'T MAKE A WINTER
CND PROVERBS
Austin

Nuclear winter

Paddy Ashdown was faced with the task of reviewing *The Cold and the Dark: The World after Nuclear War*, and asked how it is possible to review and rationally discuss the notion that nuclear war could set life on this planet back a million years (Review, 4 October, p 48). Unhappily that is what we need to do if we are to make rational decisions about war, disarmament and peace, and that is what the review failed to do in one very important respect. In his section of the book Carl Sagan wrote: "These calculations therefore are not and cannot be, assured prognostications of the full consequences of a nuclear war." Donald Kennedy wrote in his introduction about risks and not about certainties, as implied by the review.

Many of the public have been deceived by gross underestimates of the effects of nuclear war. The book answers these with an account of the very serious risks of a nuclear winter and its consequences.

There are few certainties: the risks are terrible enough.

Ian Percival
Queen Mary College
London E1

* * *

The forecasts of Paul Ehrlich and his colleagues in *The Cold and the Dark* are of such transcendental importance, if they are correct, that I would have thought it might have what readers of the *New Scientist* want is a competent scientific assessment of them and not yet another self-serving politician using the opportunity to review the book to parade his own assumed superiority over his kind.

Peter Thomson
London WC1

* * *

I follow with interest the debate on the likelihood and probable effects of a "nuclear winter" but I wonder whether a factor of some significance has not been missed from the scientific models currently being used. Will not the calorific value and smoke-generating properties of burning people be of importance in calculating—or even better, visualising—the effects of a "nuclear exchange"?

Dr R.A.A. Blackman
Burnham-on-Crouch
Essex

* * *

I must thank Paddy Ashdown for opening my eyes with his review, "Who will inherit the Earth". I had never realised that nuclear war is a dreadful thing. As he says, this revelation should change government policy. Certainly, many people who had eagerly anticipated deterring an enemy from attacking us will have to think again. Perhaps we should disarm after all and then a few bombs could destroy us without fear of either retaliation or nuclear winters.

After all, there was no nuclear winter after the "limited" nuclear attacks on Hiroshima and Nagasaki.

M.J. Brettie
Bracknell
Berkshire

Gripping discs

I found Mick Hamer's report on the poor performance of motorcycle disc brakes in the rain quite accurate when compared to my own experience and that of fellow motorcyclists (This Week, 1 October, p 3). However, I think I should point out that this problem has been removed from motorcycling for at least three years.

Prior to 1980 there was much grumbling and moaning to the dealers and manufacturers and many angry letters in the motorcycling press relating to "dodgy brakes in the wet" (due in most cases to plain organic pads in conjunction with stainless-steel discs). By 1981, however, the fault had disappeared entirely from new motorcycles, and replacement pads which did not lag or fade were available for machines of all ages from "Dunlopad" and EBC (now offered by many more companies).

With due respect to the Transport and Road Research Laboratory, I suggest it tests some relatively new motorcycles before spending any more time and money on a problem long since solved, or better still consult somebody who knows about contemporary motorcycles.

Malcolm Ingham
Fence
Lancashire

Eyeballs

I would be grateful if your readers could explain to me the following: I move my eyes from left-to-right and the object of view does not move relative to me. I move my eyes up-and-down and the object of view does not move relative to me. I move my eyes round and round and the object of view circulates. I would be grateful for the views of your readership.

Y.C. Yiu
Shaanxi Province
People's Republic of China

We welcome letters from our readers. Short communications stand the best chance of publication. We reserve the right to edit the longer ones. Write to: Letters to the Editor, *New Scientist*, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG.

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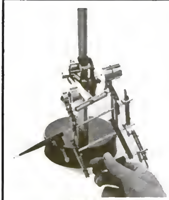

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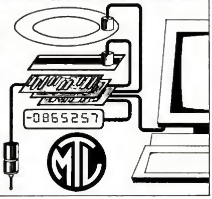

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Closing date for applications: 1 November, 1984.

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A position for a postdoctoral Research Assistant is available for a period of three years to study the effects *in vivo* and *in vitro* of toxicants on reproduction in mammals.

Previous experience in reproductive biochemistry and physiology is essential. The successful candidate will be based at the Institute of Zoology but will liaise closely with the Central Toxicology Laboratory, Alderley Park, Cheshire.

Salary according to qualifications and experience in line with University scales. Applicants should write with full cv quoting reference MRC/IZ/CTL:

Dr H. D. M. Moore,
Institute of Zoology,
The Zoological Society of London,
Regent's Park, London NW1 4RY.

Closing date, 8 November, 1984.

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Please telephone for an application form to Mrs P. Butterworth, Personnel Manager, Beecham Pharmaceuticals, (01)560 5151 Extn 3395

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The successful candidate will be a graduate scientist holding an appropriate post-graduate qualification and should ideally be able to demonstrate experience in laboratory management.

Further details, a job description and application form may be obtained from the District Personnel Officer, Wakefield Health Authority, Wood Street, Wakefield (Tel: Wakefield 370011 Ext: 240) to whom they should be returned by 29 October, 1984.

WHA Wakefield Health Authority

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THE JOB

The successful candidate will join a multi-disciplinary applied Health Physics team. The team is responsible for providing general Health Physics advice to assessment staff within SRD and plant designers throughout the Authority, evaluating health physics instrumentation and the application of new technology to Health Physics, interpreting the regulations and guidelines and assisting in plant risk assessments.

QUALIFICATIONS AND EXPERIENCE

Applicants should have an Honours Degree in Chemical Engineering, Chemistry or Physics or Corporate Membership of an appropriate Professional Institution. At least 2 or 3 years' experience and a good knowledge of Health Physics is essential and the applicant should have an interest in applying this to the advisory work of the team. A familiarity with the application of relevant regulations and guidelines is also necessary. Further training will be provided, as necessary, according to previous experience.

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THE PLACE

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For an application form and further information please write specifying Health Physicist (SRD 31) to:

PERSONNEL DEPARTMENT, NS.,
UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
SAFETY AND RELIABILITY DIRECTORATE,
WIGSHAW LANE, CULCHETH,
WARRINGTON WA3 4NE.
Tel: WARRINGTON 31244 (Ext. 1409 or 7332).

SRD

Closing date for applications is 30th November 1984

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Mr. D.R. Parkin,
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The job is based in our Statistics and Operational Research Department at our Regional Headquarters at Bexhill-on-Sea. Relocation expenses will be available in approved circumstances.

For further details and an application form please contact the Personnel Department, SETRHA, Thrift House, Collington Avenue, Bexhill-on-Sea, East Sussex TN39 3NQ. Tel (424) 222555 Ext 3145.

Ref No 4168/NS.

Closing date: 9 November, 1984.

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Please send full cv, or telephone or write for an application form to Stephanie Twigg, quoting **Ref: MV92/8931/NS.**

PA

PA Personnel Services

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Tel: 01-235 6060 Telex: 27874

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Department of Therapeutics and Clinical Pharmacology

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Further particulars and application forms from the Secretary, The University, Aberdeen, with whom applications (two copies), including a 500 word summary of proposed research, should be lodged by 16 November, 1984.

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Application form and further details of post can be obtained from Establishment Officer, University College, Cork. Tel (021) 26871, Ext 2674. Completed forms to be returned by Monday, 19 November, 1984.

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For further details and application form, please contact the Secretary, John Andrews at Houghton Poultry Research Station, Houghton, Huntingdon, Cambs. PE17 2DA. Tel St Ives (0480) 64101. Closing date for applications is 15 November, 1984.

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Electronics Engineering

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The section for Audiovisual, Electronic and Computer-based Displays (AVEC) is responsible for the creation and maintenance of animated gallery displays. In preparation for an active programme of new exhibitions the Museum wishes to consolidate and expand these activities by the addition of five new posts for Electronics Engineers. The new posts are as follows:

Head of Electronics — responsible for the electronics and computer-based activities of the Section. Will head a small expanding team of design engineers, technicians and draughting staff responsible for the creation and maintenance of new displays as well as the maintenance of existing installations. Will also be involved in circuit and system design, including microprocessor applications and have responsibility for directing and supervising the design team and support staff. Must possess a relevant degree or equivalent together with at least 5 years' post-graduate experience. **Ref: T(24)85/3.**

Microcomputer Engineer/Programmer — special responsibility to design, develop and implement working displays using micro and minicomputer technology with special emphasis on high resolution interactive colour graphics. Will also research user-interface techniques and new-media display technology. Must possess a degree or equivalent in electronic engineering or computer science with at least 2 years' experience covering micro-computer circuit and system design and a thorough knowledge of assembler and high-level language programming including high resolution graphics applications. A strong candidate with at least 5 years' experience could be appointed at the higher grade. **Ref: T(23)85/3.**

Electronics Engineers (3 posts) — circuit and system design including microprocessor applications, commissioning and documentation of special-purpose display controllers for execution in-house or under outside contract. Must possess an electronics engineering degree or equivalent with 2 years' post-graduate experience covering circuit and systems design, digital electronics (including integrated circuit and microprocessor applications) plus programming knowledge of at least one common assembler language and preferably one high level computer language. A strong candidate with at least 5 years' experience could be appointed at the higher grade. **Ref:T(23)85/3.**

SALARIES: **Head of Electronics** £11,780-£14,070; **Microcomputer Engineer/Programmer and Electronics Engineers** ranging from £8765-£11,465 or £11,780-£14,070. Level of appointment and starting salary according to experience.

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For further details and an application form (to be returned by 9 November 1984) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours). **Please quote the appropriate reference number.**

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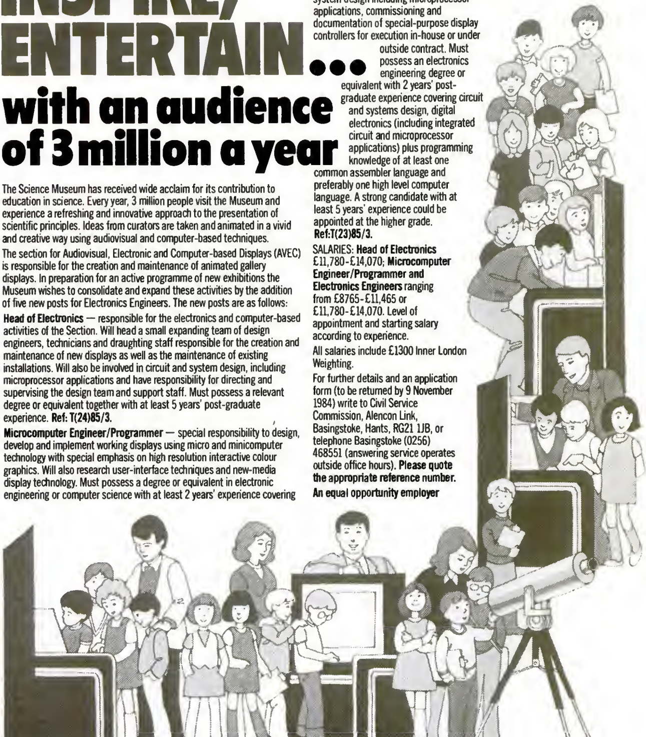

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The establishment of VG MassLab, the newest member of the VG Instruments Group of Companies, has created further opportunities for Physicists and Applications Chemists in the field of organic mass spectrometry.

The Company produces research grade analytical instruments and associated data systems for commercial laboratories throughout the world, and successful candidates would join a young, progressive team, of specialists dedicated to upholding the internationally recognised reputation of the VG Instruments Group.

Applicants should be self motivating, qualified to at least degree level and be able to demonstrate practical application in their discipline.

An attractive salary with usual fringe benefits is offered, together with a real opportunity for career development in a growing and increasingly important field of analytical science.

MASSLAB
Automated mass spectrometry

Applicants, male/female, should apply in writing with full C.V. to:

Dr. Norman Lynaugh
VG MASSLAB,
Tudor Road, Altrincham,
Cheshire WA14 5RZ.

MICROBIOLOGIST– OCCUPATIONAL HEALTH

£13,095-£16,975

This is an opportunity to join the Medical Division in HSE's London Office. The Division is responsible for HSE's policy on the application of legislation in the occupational health field for microbiology.

You will prepare technical papers for consideration by the Advisory Committee on Genetic Manipulation and the Advisory Committee on Dangerous Pathogens on matters relating to biotechnology and microbiological hazards in general, and will deal with enquiries from the scientific community concerning biotechnology and genetic manipulation. Another important role will be to liaise with government departments and other divisions of HSE, particularly with the Specialist Microbiological Inspectorate, especially in the fields of biotechnology and genetic manipulation and to help formulate microbiological advice and policy for HSE.

You should have a good degree or equivalent qualification, and a knowledge of microbiological work places, in particular laboratories and industrial concerns engaged in biotechnology. You must also be capable of dealing with specialists concerned with micro-organisms and their exploitation in industrial processes.

Appointment as Principal Scientific Officer £13095-£16975 with starting salary according to qualifications and experience. Includes £1300 Inner London Weighting.

Relocation assistance up to £5000 may be available.

For further details and an application form (to be returned by 9 November 1984) write to the Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours).
Please quote reference: S(F)677.

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Health and Safety Executive

UNIVERSITY OF SOUTHAMPTON

Department of Biochemistry

LECTURESHIP

Applications are invited for the above position now vacant due to the appointment of Dr D. P. Bloxham to a senior position at Roche Products Ltd. The post will involve the teaching of Biochemistry to medical and science students. The successful applicant will be expected to have experience in Mammalian Metabolism, and a working knowledge of Molecular Biology or Protein Chemistry would be desirable.

Salary scale: £7190-£14 125 pa (under review) depending on qualifications and experience.

Further information about the above post and about the Biochemistry Department may be obtained from Professor M. Akhtar FRS, Department of Biochemistry, University of Southampton SO9 3TU.

Further particulars may be obtained from A. J. Small, Staffing Department, The University, Highfield, Southampton SO9 5NH, to whom applications (seven copies from applicants in the United Kingdom and one from others) giving a brief cv and the names, addresses and telephone numbers of three referees should be sent before 23 November, 1984. Please quote ref: NS.

BRUNEL UNIVERSITY

Department of Mathematics and Statistics

CHAIR OF MATHEMATICS

Applications are invited for the Chair of Mathematics in the Department of Mathematics and Statistics. The person appointed will have an outstanding research record and will have demonstrated abilities of leadership in the broad area of Mathematics. He or she will be expected to take an active part in the research, teaching and managerial activities of the Department and to help formulate far-reaching ideas on the future thrust of the Department's research in Mathematics. The other Chair in the Department is in Numerical Analysis and is currently held by Professor J. R. Whiteman.

The salary will be in the Professorial range, with a minimum of £17 250, plus £1186 London Allowance, with USS benefits.

Further particulars may be obtained from the Personnel Secretary, Brunel University, Uxbridge, Middlesex UB8 3PH, Tel Uxbridge (0895) 37188, Ext 438. Closing date 12 November, 1984.

Brunel University is an Equal Opportunity Employer.

THE MIDDLESEX HOSPITAL MEDICAL SCHOOL LONDON W1P 6DB

(UNIVERSITY OF LONDON)

A physics technician is required to assist the Radiological Protection Adviser of the School and Hospital.

The duties will encompass all aspects of Radiation protection and additionally will allow experience to be gained in Radiotherapy physics.

Candidates should hold an appropriate ONC, HNC/D, O/HTEC, DCR, degree or equivalent.

Initial salary in range £5925-£7767 on scale rising to £9138.

Application forms and job description from Miss Caroline Griffin, Physics Department, The Middlesex Hospital Medical School, London W1P 6DB.

Further information from Mr L. Loverock, Radiological Protection Adviser on: 01-636 8333 ext 596.

Technical computing challenges

Do you work well under pressure, enjoy variety and have confidence in promoting your ideas?

Britoil's expanding programme of North Sea Oil Development and Production provides particular challenges for the technical specialist supporting our operational activities in Aberdeen.

Vacancies now exist within our Technical Computing Section, which consists of a small number of specialist staff providing computer services to users within the Drilling, Production and Technical Departments. Applications range from the use of sophisticated reservoir models, a range of analysis packages for structural, process and petroleum engineering, to process monitoring on our offshore platforms.

TECHNICAL SECTION CONTROLLER

We require a Senior Computer Analyst to lead the Technical Computing Section. You will direct all technical computing activities undertaken by the Computer Services Department and will also lead the support of personal computing throughout our Operational Centre. You must be able to supervise and motivate the high calibre of staff in your section and have the drive and initiative to stimulate the use of technology in a cost effective manner.

This is a senior appointment which demands a high level of experience in a technical environment and although oil industry experience would be of advantage it is not mandatory.

The importance of this appointment is reflected in a very attractive salary and benefits package which includes a company car and where appropriate generous assistance with relocation.

ANALYST/ PROGRAMMER

We also require Analysts/Programmers with experience in technical applications to assist in the work of the section. You will be expected to support technical users in their use of computer systems, and carry out the design and implementation of new systems. A high standard of work is required, with the ability to offer innovative and cost effective solutions to difficult problems, a key feature.

A generous salary and benefits package is offered and relocation assistance where appropriate.

Please apply, giving details of qualifications, experience and current remuneration package to:—The Personnel Officer, Britoil plc, St Machar House, 73/77 College Street, Aberdeen AB9 1AR, quoting reference TCC/AH/NS.

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From working papers, source codes and close liaison with the development team, your brief will be to produce concise and comprehensive user documentation. Ideally you should have experience in simulation and mathematical modelling techniques and be familiar with a high level language such as FORTRAN or PASCAL.

These positions should appeal either to technicians seeking a change of emphasis, or to authors already experienced in this field who would prefer a more autonomous role and a greater variety of interesting projects. Applicants should be willing to work in London after the initial period on location in either North West Kent or possibly North Hampshire (for which travelling expenses will be available).

Depending on your experience we are offering salaries ranging from £10K to £12K enhanced by a benefits package which is, quite simply, the best in the computer services industry and may include relocation expenses.

If you'd like to talk about your experience and how it might match our requirements, please telephone David Reeve on 01-580 5599.

Alternatively write with a full CV to
Kay McGregor, Personnel,
Scicon Ltd., 49 Berners Street,
London W1P 4AQ.

Scicon

Quality Assurance Team Leader

The Post Office is looking for a man or woman to lead a team operating Quality Assurance for phosphors, postage stamps, address coding materials, postal stationery, paper, adhesives and inks.

The post holder will also be responsible for liaison with Post Office departments, contractors and prospective suppliers.

Applicants must possess a good BSc or higher degree in chemistry or membership of the Royal Society of Chemistry, plus current experience in a quality discipline in the manufacture of the specified, or related, products.

The Post will be based in Swindon.

A trial period, normally lasting 2 years, will be served by the successful applicant.

The starting salary will be in the range of £7,717 to £13,853 depending on qualifications and experience. Benefits include 22 days leave per year and a Contributory pension scheme.

For an application form please write to Mrs J Crampton, MR2.3, Room 513, 33 Grosvenor Place, LONDON SW1X 1PX, or telephone 01-235 8000 ext. 4694.

The closing date for applications is 1st November 1984.

The Post Office

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Department of Medical Physics, St. Luke's Hospital, Guildford

SENIOR PHYSICIST IN NUCLEAR MEDICINE

Applications are invited for this new post in the Department of Medical Physics at St. Luke's Hospital, Guildford. The successful applicant will spend half his/her time developing the new nuclear medicine service at Frimley Park Hospital near Camberley and the remainder at St. Luke's Hospital providing scientific assistance to the Department of Nuclear Medicine and to other hospitals using radioactive materials in the Sub-Region. The successful applicant will be involved in maintaining the scientific and technical standards of the service and the computer processing of patient investigations as well as support for research projects. Both hospitals are equipped with modern gamma cameras and image processors and there is a radiopharmacy at St. Luke's Hospital which supplies radiopharmaceutical to the Sub-Region. An opportunity to study for a higher degree may be available.

Salary: £9415-£12 173 plus £149 fringe allowance.

Applicants, who must have four years post graduate experience with a strong element of nuclear medicine, can obtain further information by contacting Professor P. W. Horton, Chief Physicist Tel (0483) 571122, Ext 487. A job description and application form are available from the Unit Administrator, St. Luke's Hospital, Warren Road, Guildford, Surrey GU1 3NT. Tel Guildford (0483) 571122, Ext 407.

Closing date: 9 November, 1984.

INSTITUTE OF CANCER RESEARCH

a vacancy exists for a

JUNIOR TECHNICIAN

in the Institute's Cell and Molecular Biology Section, Chester Beatty Laboratories, Fulham Road SW3 studying oncogenes in human cancer. The successful candidate, who should have two 'A' levels in science subjects, will be trained in both tissue culture and molecular biology techniques. The position would also be suitable for someone wishing to spend a year or two in a laboratory before going on to university. Starting salary in range £3755-£4818 pa plus London Allowance of £1042 pa. Further information can be obtained by telephoning Dr C. J. Marshall or Dr D. Toksoz (01-352 8133, Ext 262).

Applications in duplicate with the names of two referees should be sent to the Personnel Officer, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting Ref 301/B/62.

THE SCOTTISH WILDLIFE TRUST

Loch of the Lowes, Dunkeld, Perthshire

requires an experienced

RANGER/NATURALIST

in January 1985 for its Nature Reserve and Visitor Centre at the Loch of the Lowes which has 40 000 visitors a year. The applicant should have a good field knowledge of natural history and be able to communicate effectively with the general public. A current clean driving licence is essential.

Current salary £6413 with pension scheme. Job description and application form available from and written applications with cv to Chief Executive, Scottish Wildlife Trust, 25 Johnston Terrace, Edinburgh EH1 2NH. Closing date 29 October.

Medical Information Officer

South Hampshire.

Cyanamid of Great Britain Ltd, part of the American Cyanamid Company where interests embrace pharmaceuticals, chemicals and surgical products are currently enjoying significant expansion with the major emphasis on growth being in the pharmaceutical section.

As a result of promotion, we have an opportunity for a life science graduate to join our medical information team servicing our Pharmaceutical Division, Lederle Laboratories and our surgical suture business, Davis & Geck. Ideally, you should have graduated in the last 2/3 years and should possess the personal characteristics and ability to:

- interpret complex medical papers in order to answer enquiries from the medical and allied professions;
- communicate at all levels inside and outside the Company by telephone and letter in a clear manner;
- make effective use of our sophisticated computer system for information retrieval.

Previous experience in nursing or in the pharmaceutical industry would be an advantage but is not essential.

This is a good opportunity to join a professional medical department and the benefits, including relocation assistance where appropriate to our offices in Gosport, are as would be expected from a major International Corporation.

Ring Fareham (0329) 230941 (ansafone) any day after 12 noon to obtain an application form.

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West Smithfield, London EC1A 7BE. 01-600 9000

Department of Medical Electronics

BASIC GRADE PHYSICIST

required to become involved in providing physics and engineering support for a range of research projects concerned with the assessment of NMR imaging. A 1st or 2nd class Honours degree in electrical engineering or physics and some experience in the design and development of medical instrumentation is essential.

For further information contact Mr C. Callicott on 01-600 9000 ext 2291.

Job description and application form available from the Personnel Department on 01-600 900 ext 3188 quoting ref NT/150.

Closing date 2 November, 1984.

Oxford Research Systems

Oxford Research Systems Limited has established a leading position in the supply of advanced Nuclear Magnetic Resonance (NMR) spectrometers for research in medicine and biology. NMR has emerged as an important, investigational technique in the biomedical field and is being used to an increasing extent for research and clinical diagnosis.

In line with our expansion programme we now have immediate vacancies for engineers and scientists in the following departments:

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To work on a number of areas including:

☐ Design of radiofrequency hardware/electronics for NMR spectrometer systems
☐ Development of instrumentation and techniques used in NMR spectroscopy and imaging

Software

To work on minicomputer and array processor systems with particular emphasis on:

☐ Fourier Transform techniques
☐ NMR spectral/image data processing

NMR Systems

To work on product oriented projects including:

☐ Conceptual design of spectrometer systems
☐ System evaluation and testing
☐ System production coordination

A good honours degree in a physical science or mathematical discipline is preferred together with two years post graduate experience in research or industry. Applications from physicists/chemists/NMR spectroscopists are welcomed although a background in NMR is not essential. Applicants should be enthusiastic and possess the initiative to work in a challenging environment.

Oxford Research Systems Limited, as a British member of the Bruker Group, is concentrating on the development, manufacture and support of high-field NMR systems for use in medicine and biology. Bruker is a European company with a worldwide network of subsidiaries.

We offer competitive salary and benefits, including relocation assistance where necessary, combined with pleasant conditions in well-equipped laboratories.

Please write giving details of qualifications and experience to
Katie Douet,
Oxford Research Systems,
Nuffield Way, Abingdon,
Oxfordshire OX14 1RY

OXFORD RESEARCH SYSTEMS
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Development Chemist

Conductive inks for thick film microelectronics

As a major chemical company providing a specialist service to the electronics industry, our client now wishes to appoint an experienced Chemist to carry out a complex programme of work on the development of conductive inks for use in the manufacture of microelectronic circuits.

Essential requirements are a degree in Chemistry, Materials Science or other appropriate discipline, coupled with at least two years' relevant experience in the use of conductive inks and related products in the electronics industry.

Particularly important is innovative ability and the personality and communication skills to liaise closely with end users in carrying out customer service work. The appointment, which is located in a pleasant rural area of the Home Counties, is open to both men and women and preferred age is under 30.

The Company offers a competitive salary together with first-class working conditions and an attractive range of benefits, including substantial assistance with relocation where appropriate.

Please write with full cv to Confidential Reply Service, Ref BWD 146, Austin Knight Advertising UK Limited, 22 Prospect Place, Welwyn, Herts. AL6 9EN.

Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Confidential Reply Supervisor.

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Jordan is an attractive country in every sense of the word.

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As well as the salaries quoted, there is an extensive benefits package that includes features like free accommodation and free medical care. 42 days holiday a year would give you time to explore the Middle East; two free return flights to the UK during your 18 month contract would help you keep in touch with people and events at home.

To find out more about the special attractions of working with IAL in Jordan, write or telephone to John Callow, quoting Ref: M100.

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These are two vacancies at the Commonwealth Bureaux of Pastures and Field Crops, Hurley, Maidenhead. Duties include scanning and abstracting the world literature on annual field crops, grasslands, herbage plants, weeds and weed control for publication in the CAB database.

Degree in agriculture, plant or related science essential. Reading knowledge of at least one language other than English desirable. Salary in scale £5682-£9561 pa (under review). Starting salary in accordance with qualifications and experience.

Closing date for applications: 5 November, 1984.

For application forms and further details write or telephone to:

Commonwealth
Bureaux of
Pastures and Field
Crops, Hurley,
Maidenhead,
Berks SL6 5LR
Tel Littlewick Green
3457

THE UNIVERSITY OF ASTON IN BIRMINGHAM

Department of Chemistry

SERC POST-DOCTORAL RESEARCH FELLOW

Applications are invited for a post-doctoral research fellowship to study the reactions of polymers in gaseous plasmas using mass spectrometry as the principal tool.

This grant has been awarded under SERC's specially promoted programme in electroactive polymers and relates to the use of polymers in novel photo-resists for the manufacture of integrated circuits. Substantial funds are available for converting existing apparatus and for new equipment.

The appointment is for two years with a starting salary within the range £7190 to £8530 pa (under review). Informal enquiries may be directed to Dr S. J. Moss, Department of Chemistry, Ext 4762.

Application forms and further particulars may be obtained from the University Secretary (quoting reference 642/32), University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET. (Tel 021-359 3611 Ext 4564). Closing date for the receipt of applications is 2 November, 1984.

ROYAL POSTGRADUATE MEDICAL SCHOOL
(University of London)

DEPARTMENT OF MEDICINE

(Respiratory Division)

RESEARCH ASSISTANT required to work on a project funded by the Medical Research Council, investigating peptide receptors in lung. The successful candidate would be involved in receptor binding and autoradiography studies which are already in progress. The applicant should have some experience in pharmacology or physiology and should possess a degree or equivalent. The appointment is for one year.

Salary £5305 plus £1042 London Allowance.

Application forms and further particulars can be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS, quoting ref no 2/217/NS.

Closing date: 8 November, 1984.

Cell Biology

Greenford, Middlesex

The Oncology Section of our Cell Biology department are investigating new approaches to cancer chemotherapy and, in order to augment the existing team, we require a **GRADUATE BIOLOGIST**, to assist in the critical *in vivo* evaluation of potential cancer chemotherapeutic agents. Candidates should have at least an upper second class honours in an appropriate biological discipline, with an especial interest, and possibly some experience, in oncology, although training will be given where necessary.

A TECHNICIAN is required in the Cell Kinetics Team of the same department to operate and be responsible for the day-to-day running of an Ortho Cytofluorograph System 50 coupled to an Ortho 2150 computer. The team studies the cell kinetics of normal and tumour cell systems following drug treatment and other techniques include cell surface labelling for the examination and identification of cells. Candidates should have an HTEC or other suitable technical qualification and have an interest in complex instrumentation and the development of analytical methods. Again, training will be given where necessary, but we are looking for someone with initiative, a conscientious attention to detail and the ability to solve mechanical problems.

The company offers excellent conditions of employment including a non-contributory pension scheme, bonus schemes, subsidised canteen and an active sports and social club.

Please send a full cv or write for an application form to: The Personnel Officer (REN), Glaxo Group Research Ltd. Greenford Road, Greenford, Middlesex UB6 OHE, quoting reference number AQ/548.

***Glaxo** Group Research Ltd.*

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Lansdowne Appointments Register,
Park House, 207-211 The Vale,
LONDON W3 7QB

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Business expert. Lawyer. Negotiator. Detective. Manager. Today's Tax Inspector needs an exceptional range of skills to assess the tax liabilities of companies and businesses of all types and sizes. For graduates seeking a stimulating and progressive career which is different this is an option that would be hard to match anywhere and is certainly a far cry from the popular image.

Intensive training will enable you to handle your own casework within a few months of joining. After 3 years, you will be running a sizeable team of staff and, in due course, you should be running your own tax district.

Qualifications: Under 36 and a First or Second class honours degree or an acceptable equivalent qualification. Final Year Students may apply.

Starting salary according to qualifications and experience from £6015 to £8625 for those aged under 26 and up to £9495 for those over 26. You should be earning at least £9135 after 2 years and, 3 years later, you should be on a scale rising from £12,895 to £17,485. If you fulfil your promise, you should later be on a scale rising to £21,830. Beyond this there are opportunities for further promotion to the most senior grades in the Civil Service. SALARIES HIGHER IN LONDON. Training can usually begin at an office in the area of your choice.

To find out more and for an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours).
Please quote ref: A/85/320/176.

The Civil Service is an equal opportunity employer.

JUNIOR TECHNICIAN

Technician required with experience in histology. Minimum qualifications O level TEC. Opportunity to expand into immunohistochemistry. This is a long term, pensionable post with starting salary up to £5491 depending upon age and qualifications. Apply in writing with full cv and two referees to: The Secretary, Strangeways Research Laboratory, Worts' Causeway, Cambridge CB1 4RN.

NEW HALL, CAMBRIDGE

Applications are invited from school teachers of chemistry to spend a term at New Hall during the academic year 1985/86 as a Salters' Company Commoner Fellow. Particulars may be obtained from the President, New Hall, Cambridge, to whom applications should be sent by 28 January, 1985.

ASSISTANT CONSERVATION OFFICER (BERKSHIRE)

The Berkshire, Buckinghamshire & Oxfordshire Naturalists' Trust (BBONT) requires a full-time county based officer to take responsibility for the Trust's conservation work in Berkshire.

Salary £4725 pa plus car allowance. Send sae for further details. Closing date 5 November, 1984.

BBONT, 3 Church Cowley Road, Oxford OX4 3JR.

SILSOE COLLEGE
(Cranfield Institute of Technology)
STATISTICIAN

Silsoe College forms the Faculty of Agricultural Engineering, Food Production and Rural Land Use of the Cranfield Institute of Technology, awarding degrees in Agricultural Engineering, Land and Water Management and Marketing and Management. The College currently has 110 undergraduate students and 220 postgraduates. A wide range of research and consultancy services is also undertaken.

We need a Teaching Associate in Statistics, Computing and Mathematics, who will assist in teaching and advising research staff and students in Statistics and the use of computing facilities (including GENSTAT and SPSS) and some tutorial work in Mathematics.

Candidates should have a good honours degree or equivalent in Statistics or in a science subject with postgraduate qualifications or experience in Statistics.

The appointment is for two years with a salary in the range £6310–£8530 pa (under review).

Application forms and further particulars may be obtained from the Head of Administration, Silsoe College, Silsoe, Bedford MK45 4DT. Tel Silsoe (0525) 60428.

EDITORIAL VACANCY

£5000-£6000

Chemistry and Industry, the twice monthly magazine published by the Society of Chemical Industry, is looking for someone to edit and see article-length manuscripts through the press. The magazine caters for technically-based management in a wide range of industries where chemistry is significant and the articles published reflect this. In addition, the articles cover many other areas of science and technology, together with fields such as economics related to successful industrial innovation. We need someone to help authors who have something to say to get their message across to readers in the most effective manner.

This is an office-based job requiring a sound understanding of chemistry, a sensitive appreciation of the English language and the ability to deal tactfully but firmly with authors, artists and printers. Ideally, we are looking for someone with one to two years' experience, but we are willing to consider new entrants who fulfil the first two requirements; they will be taught the rest.

Please write, enclosing a cv, to The General Secretary, Society of Chemical Industry, 14-15 Belgrave Square, London SW1X 8PS.

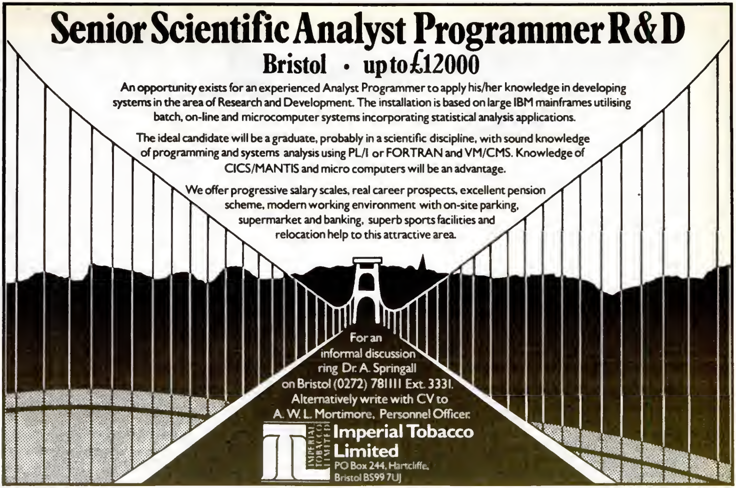
GLASSHOUSE CROPS RESEARCH INSTITUTE
Crop Protection Division
TEMPORARY ENTOMOLOGIST/MYCOLOGIST

A temporary Higher Scientific Officer is required to work in the Insect Pathology Section and overseas on research on fungal diseases on insects, initially the brown plant hopper on rice. The appointment will be for two years.

Qualifications required – First or Upper Second honours degree with at least two years' relevant post-qualifying experience.

Salary £7435-£10 039 depending upon qualifications and experience. Non-contributory superannuation scheme. Annual leave 22 days.

Application form and further details from GCRI (Ref MRB/389), Littlehampton, W. Sussex BN17 6LP. Closing date 31 October.



Senior Scientific Analyst Programmer R&D

Bristol • up to £12000

An opportunity exists for an experienced Analyst Programmer to apply his/her knowledge in developing systems in the area of Research and Development. The installation is based on large IBM mainframes utilising batch, on-line and microcomputer systems incorporating statistical analysis applications.

The ideal candidate will be a graduate, probably in a scientific discipline, with sound knowledge of programming and systems analysis using PL/I or FORTRAN and VM/CMS. Knowledge of CICS/MANTIS and micro computers will be an advantage.

We offer progressive salary scales, real career prospects, excellent pension scheme, modern working environment with on-site parking, supermarket and banking, superb sports facilities and relocation help to this attractive area.

For an informal discussion ring Dr. A. Springall on Bristol (0272) 781111 Ext. 3331. Alternatively write with CV to A. W. L. Mortimore, Personnel Officer.

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You should be familiar with circuits and sub-systems for advanced data communication systems involving LSI production techniques, single chip microprocessors and digital signal processing.

We are particularly looking for graduate electronic design engineers with 3-4 years' analogue/digital experience in the communications industry.

Salaries are highly competitive, working conditions are excellent in our recently refurbished design laboratory and benefits include relocation expenses where appropriate.

To apply please contact Trevor Davies on 01-890 1477 today. Alternatively send your full CV to him at THORN EMI Datatech Limited, Spur Road, Feltham, Middlesex TW14 0TD.

THORN EMI

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Pharmaceutical Analysis

Due to an expansion in European product support activities, the Merrell Dow Résearch Institute at Egham now wishes to recruit a further Pharmaceutical Analyst in the Analytical Chemistry Department.

The person appointed will be assigned analytical projects associated with supporting a wide range of products marketed within Europe including both Merrell Dow and Lepetit preparations. The work will be of a non-routine nature, including method development and will involve close liaison with research pharmacists and production personnel. The ideal candidate will be a chemistry or pharmacy graduate or equivalent with 2 – 3 years' experience in the pharmaceutical industry, in a research or quality control environment, and will be familiar with the application of HPLC and GLC (plus computerised data handling) as well as general analytical techniques. The ability to communicate effectively within an international industrial research environment is essential.

Merrell Dow is a major international pharmaceutical company and as such our remuneration package will include a generous relocation allowance, competitive salary and pension scheme, life assurance, first rate subsidised restaurant and the usual fringe benefits associated with a large company.

For an application form and further details please contact: Mrs. D. Helmer, Personnel Manager,
Merrell Dow Pharmaceuticals Limited,
Meadowbank, Bath Road,
Hounslow TW5 9QY. Tel: 01-759 2600.

Merrell

MERRELL DOW PHARMACEUTICALS LIMITED

POLYMER RESEARCH
RUBBER IN ENGINEERING
A vacancy exists for a
RESEARCH FELLOW

to work on the properties of rubber related to engineering applications initially for a period of two years with the possibility of permanent appointment. A good Honours degree is essential. Experience in the rubber industry would be an advantage.

Topics currently under investigation include: Engineering design with rubber. Rubber/fibre composites. Seismic protection of structures.

The successful candidate would be expected to work in one of the above fields.

Applications with cv and naming two referees should be addressed to: The Director (Ref. AS) The Malaysian Rubber Producers' Research Association, Brickendonbury, Hertford SG13 8NL.

UNIVERSITY OF OXFORD
DEPARTMENT OF
CLINICAL PHARMACOLOGY
Radcliffe Infirmary
Oxford OX2 6HE

TECHNICIAN

required for a research project concerned with the neuro-pharmacological mechanisms of emesis. The project involves the use of a number of histological, physiological and anatomical techniques and familiarity with one or more of these fields would be an advantage.

The appointment will be initially for two years. Applicants should have HNC, degree or equivalent qualifications. Salary will be in the range £5591–£7747 pa depending upon age and experience.

Applications, giving details of qualifications and experience, together with the names and addresses of two referees, should be sent to Mr. J. A. Rose at the above address by 11 November, 1984.

MICROBIOLOGY MANAGER

We are a research based company specialising in the manufacture of ophthalmic and dermatological products who wish to expand our technical team by the appointment of an experienced microbiologist to manage our microbiology department.

Reporting to the Quality Control Manager, the successful applicant would be responsible for microbiological validation and the efficient planning of a production orientated department.

Candidates must be qualified to Honours degree level with a minimum of five years' experience in a similar position within the pharmaceutical industry. He/she will be required to demonstrate a proven technical ability as well as effective communication skills.

Please write with full cv or send for an application form to:

Mr L. Dorrell,
Divisional Personnel Manager,
Smith and Nephew Pharmaceuticals Ltd,
Bampton Road,
Romford, Essex RM3 8SL.

Smith+Nephew

PHYSICIST/MATHEMATICIAN

A graduate Physicist or Mathematician is required to join the Spray Physics Group which is carrying out research into Electrostatic Spray Technology. The successful applicant will be expected to develop mathematical models and to carry out experiments to investigate the validity of the models.

Applicants should have a first or upper second class honours degree in Mathematics/Physics/Engineering with a strong interest and ability in using mathematical techniques.

Salary £5682 - £9561 per annum according to experience (pay award pending).

There is a non-contributory superannuation scheme.

Further details and application form from the Personnel Officer, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedford MK45 4HS. Telephone: (0525) 60000.

The British Society for Research in Agricultural Engineering is an Equal Opportunities Employer.

NIAE

Knowledge Based Systems

NEWCASTLE UPON TYNE up to £11,645 pa

The British Gas Engineering Research Station, near Newcastle upon Tyne, has an important vacancy in the field of knowledge based systems development.

A new division has just been established to investigate and exploit advanced information technology. A Senior Engineer is required to provide a vigorous lead in the design and implementation of knowledge based systems. The post demands an imaginative person who has a background in computer science or engineering. Experience of knowledge based system development or AI programming languages would be an advantage.

Applicants should have an honours degree and at least 4 years post graduate experience. They should be able to demonstrate a capability of taking developments from the laboratory into trials, and through to completion.

Salary will be within a range up to £11,645. Benefits are those you would normally expect from a large progressive organisation, including relocation expenses where appropriate.

Please write or telephone for an application form, quoting reference ERS/312, to: Senior Personnel Officer, British Gas, Engineering Research Station, Killingworth, Newcastle upon Tyne NE99 1LH. Telephone: Tyneside [091] 2684828 ext 160.

BRITISH GAS

COMMONWEALTH AGRICULTURAL BUREAUX
Applications are invited for the position of

TAXONOMIST

in the
COMMONWEALTH INSTITUTE OF ENTOMOLOGY
(TAXONOMY/IDENTIFICATION SERVICE)

Duties: To provide identifications and supportive research and training in the COLEOPTERA, chiefly in the families Coccinellidae, Buprestidae, Tenebrionidae and Cerambycidae. The appointee will be a member of the Institute's Taxonomy/Identification Service which is located in the British Museum (Natural History) in London, UK.

Qualifications: A higher degree in Entomology, preferably with emphasis on taxonomy.

Terms of appointment: An appointment may be made on a permanent basis, alternatively secondment or a term appointment for five years would be considered.

Salary: In the scales £5682—£7765; £7149—£9561 with Inner London Weighting of £1250 pa, with the possibility of progression to higher scales. The initial salary will be according to age, qualifications and experience.

Application forms and further particulars are available from the Director, Commonwealth Institute of Entomology, 56 Queen's Gate, London, SW7 5JR, UK.
Closing date for receipt of applications: 31 January, 1985

WORLD SERVICES TO AGRICULTURE
C·A·B

Clinical Research Associate

As a major international pharmaceutical company our clients are always looking for the right personnel to maintain their position as one of Europe's market leaders.

Their current need is for a clinical research associate to work at their British headquarters in the Home Counties.

The ideal candidate will be aged 27-30, qualified to PhD level in Life Sciences, Chemistry, Biochemistry or Pharmacology. Preference will also be given to those who possess a sound working knowledge of the French language, although this is not essential.

The principal responsibility of the person appointed will be to assist the Director of Development with the co-ordination of clinical trials through Phases I, II and III up to preparation of licensing submission.

Previous experience in the fields of respiratory or metabolic disorders, or cardiology would also be a distinct advantage.

This appointment offers a competitive salary together with a generous benefits package.

Please send a handwritten letter of application with comprehensive C.V. and photograph to Confidential Reply Service, Ref. AMC 9097, Austin Knight Advertising Limited, London, W1A 1DS.

Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Confidential Reply Supervisor.

Austin Knight Advertising

ELECTRONICS/SOFTWARE RESEARCH ENGINEER

to join a biophysics team developing a wide range of techniques including measurement of radiation-induced reactions on a nanosecond timescale, development of clinical and laboratory RF hyperthermia techniques for cancer treatment, recording the growth of individual cells using digitized imaging techniques and monitoring of tissue oxygen and pH levels with micron resolution. Also a variety of instrumentation for use with our Van de Graaff and linear accelerators, X-ray and other radiation sources is continuously under development.

Degree or equivalent in electronics, computer science or a related discipline required. The successful applicant will be familiar with analogue and digital techniques and programming to interface instrumentation to the laboratory's PDP11 machines and to microprocessors.

If you would like to work in pleasant surroundings, applying your expertise to an unusually wide variety of research and with the possibility of studying for a higher degree write or 'phone for further information and application form to:

The Administrator, (Ref. 5/NS),
Gray Laboratory, Mount Vernon Hospital,
Northwood, Middx. HA6 2RN.
Tel: Northwood 28611.

Cancer Research Campaign

Formulation Process Section Head

c.£11,000 ***initially based Essex***

May & Baker Ltd. is one of the UK's leading agrochemical companies and part of the Rhône-Poulenc Group. We now wish to create a new section to be responsible for pilot studies on agrochemical formulations and seek a Section Head to lead a specialised team in this field.

The responsibilities of the section will include the preparation and provision of supplies of experimental formulations for field trials, scale-up studies necessary for the commissioning of formulation works processes, and evaluation of plant equipment for the manufacture of the complete range of M & B Agrochemical products. There will be a need for close liaison and exchange of ideas with production staff at Norwich.

Candidates, educated to degree level or equivalent in Chemistry should ideally have previous experience in the formulation of agrochemicals, or products from similar industries. Of particular value will be experience in production and process design. The ability to lead and motivate the section with minimal supervision is essential.

It is intended that this post, which will be initially based at Dagenham, will be relocated within 2 years to our Norwich manufacturing site. Occasional visits to overseas manufacturing sites for on-site investigation and supervision of production will be necessary.

Salary will be c.£11,000, dependent on ability and experience. Excellent benefits are those appropriate to a major company and will include assistance with relocation expenses where applicable.

M&B May & Baker

Please write with full CV to:

Gareth James,
Personnel Officer,
May & Baker Ltd.,
Fyfield Road,
Ongar, Essex CM5 0HW.

TEESSIDE POLYTECHNIC

An Equal Opportunity Employer

DEPARTMENT OF CIVIL AND STRUCTURAL ENGINEERING AND BUILDING

LEA RESEARCH ASSISTANT (STRUCTURES)

Applications are invited for the abova post to work on an investigation concerned with the behaviour and optimum design of timber framed buildings. The appointment will be made as soon as possible for a period of three years only.

Candidates must possess at least an upper second class honours degree in Civil Engineering. Experience in timber design and an interest in microcomputers would be a distinct advantage. The successful candidate will be required to register with the CNAA for PhD and contribute to the teaching work of the Department for up to six hours/week.

Salary, which includes payment for up to 6 hours teaching assignment per week £5910–£6657 pa.

Application forms and further particulars available from the Personnel Section, Teesside Polytechnic, Borough Road, Middlesbrough, Clevaland TS1 3BA.
Tel (0642) 218121, Ext 4114.
Closing data for applications:
16 November, 1984.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE

JUNIOR RESEARCH TECHNICIAN/RESEARCH TECHNICIAN

required to raise monoclonal antibodies to bone cells and study their application in bone tumours. Some immunology experience would be an advantage.

Applicants must hold at least two Science 'A' levels.

Post is available immediately and is funded by the Cancer Research Campaign for 15 months in the first instance.

Applications in the form of a Curriculum Vitae with the names of two referees to Dr M. A. Horton, Department of Haematology, St. Bartholomew's Hospital, West Smithfield, London EC1A 7BE.

Closing Date: 31 October, 1984.

UNIVERSITY OF NEWCASTLE UPON TYNE
Department of Electrical and Electronic Engineering

Applications are invited for the post of

LECTURER

in the Department of Electrical and Electronic Engineering, from candidates with an interest in CAD for VLSI circuits.

Applicants will be expected to be suitably qualified and to have had postgraduate experience either in industry or in a University in a field related to VLSI design.

This post is one awarded to the University by the UGC in its IT initiative to strengthen research in the existing VLSI design group in the Department of Electrical and Electronic Engineering and the Computing Laboratory at Newcastle.

Salary will be at an appropriate point on the Lecturers' scale £7190-£14 125 (under review) according to age, qualifications and experience.

Further particulars may be obtained from the Senior Assistant Registrar (FP), The University, Registrar's Office, 6 Kensington Terrace, Newcastle upon Tyne NE1 7RU, with whom applications (three copies) together with the names and addresses of three referees should be lodged not later than 8 November, 1984. Please quote Reference NS.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
Rock Mechanics Information Service

INFORMATION SCIENTIST/EDITOR

required to assume editorial responsibility for the production of the abstracts journal and online data base Geomechanics Abstracts. Main duties include the scanning, selection, abstracting and indexing of rock and soil mechanics literature; overseeing the input of data; proofreading; online searching; supervision of staff (one information and one clerical).

Several years experience in the information profession, particularly in abstracting/indexing is desirable. Familiarity with microcomputers is an advantage.

Salary within range £7496-£11 061 (including London Allowance) (under review) depending on experience. Five weeks annual leave plus use of many College facilities.

Please apply as soon as possible with cv to: Rock Mechanics Information Service, Imperial College, Royal School of Mines, Prince Consort Road, London SW7 2BP.

WESSEX REGIONAL IMMUNOLOGY SERVICE,

Southampton General Hospital,
Tremona Road,
Southampton

Applications are invited from

GRADUATES

to work on a research project involving the characterisation of antibodies reacting with renal endothelium in allograft rejection.

The position is for one year leading to a permanent appointment as scientific officer in the NHS (Whitney Council PTA). Experience in histological techniques an advantage but not essential as training will be provided. Starting salary £6277 pa. Further information, application forms and job description from District Personnel Department, Tremona Court, 30/32 Tremona Road, Southampton. Tel Southampton 777222, Ext 3018/3556. **Closing date 8 November, 1984.**

THE NEW SOUTH WALES
INSTITUTE OF TECHNOLOGY
SYDNEY, AUSTRALIA
Equal Employment Opportunity is Institute Policy

VICE-PRESIDENT

A$54,486 p.a.

(Subject to indexation)

The New South Wales Institute of Technology is a corporate institution of higher education established in 1965 whose object is to provide a range of studies and research opportunities for those wishing to enter or advance in professional work. The governing body of the Institute is the Council which is comprised of members nominated by the Minister, member elected by staff and students and ex officio members. The President is the chief executive officer of the Institute.

The teaching and research work of the Institute is carried on in eight Faculties, namely, Architecture and Building, Business, Engineering, Humanities and Social Sciences, Law, Life Sciences, Mathematical and Computing Sciences and Science. In 1984 some 9000 students are engaged in studies leading to admission to Bachelor's and Master's degrees and the award of Graduate Diplomas.

The Council of the Institute now invites applications for appointment to the position of Vice-President. The Vice-President has a major role in creating policy for academic planning and the implementation of course work in the several faculties. In connection with this work the Vice-President will assume responsibility for educational facilities including the Library and the Computer Centre. Additionally the incumbent will work with the President in the general development and administration of the Institute and will deputise for the President in the latter's absence.

It is anticipated that applicants will possess high academic qualifications and can demonstrate experience in tertiary education administration at an appropriate level. A close appreciation of the educational needs of the industrial and commercial community would be expected.

CONDITIONS OF APPOINTMENT

Fares and a contribution toward removal expenses are provided for overseas appointees. A Housing Loan Scheme is also available. With consent of Council, academic staff are permitted to undertake limited consulting work.

Applications should include full details of academic and professional background. The names and addresses of three referees, from whom confidential reports may be obtained, should be included. In reply please quote reference No. 84/169. Applications close 16th November, 1984.

Details of conditions of employment and further information regarding this position can be obtained from:

The Director,
N.S.W. Government Office,
66 Strand,
LONDON WXC2N 5LZ

1645

Senior Development Analyst

LOUGHBOROUGH

The Pharmaceutical Division of Fisons has a world-wide reputation as an innovator and leading manufacturer of ethical pharmaceuticals. Research and Development takes place in our purpose-built laboratories situated in Loughborough in the heart of rural Leicestershire.

This is a particularly interesting and challenging job for an experienced Analyst who will join a small team involved in developing the specification and methods of analysis for new drug substances in order to determine their purity and stability.

Applicants should possess a degree in Chemistry - preferably with further post-graduate qualifications - and the knowledge and experience of analytical techniques needed to handle a senior non-routine investigative position. You should have gained considerable relevant experience in the pharmaceutical industry - including the use of chromatographic techniques.

We offer excellent conditions of employment which include profit sharing bonus, flexitime, 23 days annual holiday plus generous relocation assistance, where applicable, to this attractive part of the country.

Please write for an application form quoting reference RD46 to

Mrs Olive Jones, Personnel Officer,
Science & Technology Laboratories,
Fisons plc Pharmaceutical Division,
Bakewell Road, Loughborough,
Leicestershire LE11 0RH.

FISONS Pharmaceuticals

ROYAL HOLLOWAY AND BEDFORD COLLEGES

BIOCHEMISTRY DEPARTMENT

Instrument Technician Grade 6 required to carry out servicing and maintenance of equipment and instruments. The post is based at Egham.

Salary scale £8048-£9515 a year.

PHYSICS DEPARTMENT

Mechanical Workshop Technician required to construct and machine equipment and components. Duties will include assisting in the general upkeep of the workshops and maintaining equipment.

Salary scale £7081-£8184 a year.

Purchasing Assistant required to prepare and process orders, input data to the computer, maintain and update records. Knowledge of scientific terms and laboratory supply would be useful.

Salary scale £6570-£7645 a year.

Both of the Physics Posts will be based at Regent's Park, London for one year and will then transfer to Egham.

Applications giving details of age, experience, qualifications and current salary together with the names and addresses of two referees, should be sent to **Mrs A. J. Overington, Administrative Officer (Personnel) Royal Holloway and Bedford Colleges, Egham Hill, Egham, Surrey, TW20 0EX.**

THE EAST OF SCOTLAND COLLEGE OF AGRICULTURE
THE EDINBURGH SCHOOL OF AGRICULTURE

ADVISORY ENTOMOLOGIST/NEMATOLOGIST

GRADE IV/III

Applications are invited for the post of Advisory Entomologist/Nematologist in the College's Crop Protection Department in Edinburgh. The duties include advisory and development work on all locally relevant aspects of pest control, but the appointee will take particular responsibility for nematology.

Applicants should have an honours degree in Agricultural Zoology, Agricultural Science or a related subject and relevant post-graduate experience. Candidates must hold a valid UK licence to drive a motor vehicle.

Salary scale: £5682-£11 476 per annum (maximum) according to qualifications and experience.

Application forms and further particulars may be obtained from The Secretary, The Edinburgh School of Agriculture, West Mains Road, Edinburgh EH9 3JG. Ref. 280 should be quoted in all communications and closing date is 5 November, 1984.

Knowledge Engineer

...with knowledge in one or more of Psychology, Computing, Linguistics and a Physical or Biological Science

UNILEVER RESEARCH at Port Sunlight has an excellent career opportunity for a Knowledge Engineer to join the Operational Techniques Section within their Laboratory. Operational Techniques Section, which services the Laboratory, covers Mathematics, Statistics and Knowledge Engineering. It has established the importance and value of the contribution that Knowledge Engineering can make.

The challenge is in the application of new ideas, concepts and tools that are coming from the research into Artificial Intelligence, to meet the needs of research and industry. There is considerable co-operation with Universities and Polytechnics.

Candidates must be imaginative, have a good degree and preferably a post graduate qualification, and ideally have knowledge in Psychology, Computing, Linguistics and a Physical or Biological Science. They should possess the personality and approach to achieve close collaboration with the Laboratory's multi-disciplinary staff.

We operate a progressive salary and promotion policy, good superannuation and life cover benefits and, where appropriate, will assist with relocation expenses.

The Laboratory is situated on the Wirral peninsula, a few miles from the sea and convenient for Chester, Liverpool and North Wales.

Please send fully detailed C.V., quoting reference PS10/84, to:

The Personnel Officer,
Unilever Research,
Port Sunlight Laboratory,
Quarry Road East,
Bebington, Wirral,
Merseyside L63 3JW.

PARASITOLOGIST

CAREER OPPORTUNITY – ANIMAL HEALTH R&D

As part of the continuing development of our Animal Health R & D Group at Sandwich we are seeking an experienced Parasitologist who is capable of contributing effectively at the forefront of applied research.

In addition to leading a team of experienced Biologists in primary anti-parasitic screening and rapidly progressing the active agents to secondary evaluation in use animals, you will devote a major portion of your time to basic research into new anti-parasitic screening models.

You must be dedicated to the discovery of new animal health drugs and have at least three years post-doctoral experience in industry or academia with a sound working knowledge of helminth infections in laboratory models. Experience of the *in vitro* culture of helminths, while not essential, would be a distinct advantage.

This appointment offers you an exciting opportunity to lead your own research team together with excellent opportunities for personal and career advancement. We are offering a highly competitive starting salary together with good bonus, pension and life assurance schemes, generous assistance in relocating to an attractive semi-rural area of coastal Kent, flexible working hours and an active sports and social club with first-class amenities.

Please write in confidence, quoting reference NS2, giving full details of career to date to Mr D. P. O'Callaghan, Pfizer Central Research, Ramsgate Road, Sandwich, Kent, CT13 9NJ.

Pfizer

Agricultural and Food Research Council

FOOD RESEARCH INSTITUTE
Nutrition & Food Quality Division

INORGANIC CHEMIST
Higher Scientific Officer

3 Year Project
(Re-advertised Post)

An Inorganic Chemist is required to develop studies on the effects of modern food processing methods on the bioavailability of essential nutrients. This is a three-year project funded by the Ministry of Agriculture, Fisheries & Food. The post will involve the development and application of methods for the study of bioavailability and will call for an interest in the application of advanced inorganic mass spectrometry in the study of inorganic nutrient availability. Experience at the postgraduate level in inorganic mass spectrometry is desirable, together with an interest in contributing as an inorganic chemist in biological studies.

Qualifications:

A first or upper second class honours degree in Chemistry with at least two years post-graduate experience in inorganic chemistry. An interest in working on biological problems is essential.

Salary.

On a scale £7149–£9561 (under review). Non-contributory superannuation scheme.

The Agricultural and Food Research Council is an Equal Opportunities Employer.

Further information and application form from the Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA, quoting reference 84/NP/1. Telephone enquiries to the Registry (0603 56122 Ext 230).

Closing date: 1 November, 1984.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

Scientific Officer in Physiology Department

ONE YEAR APPOINTMENT

A temporary SO is required to join a group of staff in the Physiology and Dairy Husbandry departments working on the effects of growth hormone on dairy cow production and fertility.

The person appointed will assist in the day-to-day running of a large-scale experiment; collate, punch and summarise data, and undertake hormone and metabolite analyses.

The post is for 12 months and the person appointed should have a degree/HND in Animal Physiology, Animal Production or Animal Science or a related subject.

Appointment will be at the Scientific Officer Grade; salary scale £5682 to £7765.

Applicants should apply in writing, enclosing a full cv to The Secretary, NIRD, Shinfield, Reading RG2 9AT. Please quote Reference 84/28.

NIRD is an Equal Opportunities Employer.

KING'S COLLEGE SCHOOL OF MEDICINE & DENTISTRY
of King's College London
Denmark Hill London SE5 8RX

RESEARCH FELLOW
(NON-CLINICAL)
Liver Unit

Applications are invited from suitably qualified persons to work in the field of immunology of liver disease. The successful applicant is likely to have had at least three years experience in the use of cellular immunological methods (with proven ability to train staff to work with such techniques) and their application to the study of pathogenetic mechanisms in disease.

Starting salary will be at a point on the Research Assistants/Fellows, Grade 1A/1B scales appropriate to the candidate's experience and qualifications.

Applications, including full cv and names of two referees, should be addressed to The Secretary at the above address by 9 November, 1984.

Organic Chemist/ Immunologist/Cell Biologist

A Career in Information Science

Our company is the centre for Research & Development within the Glaxo Group, the only British group in the world's top twenty pharmaceutical companies.

We urgently require an organic chemist and an immunologist/cell biologist to join the Literature Services section of our Information Services Department, whose responsibilities encompass information provision to multi-disciplinary research project teams.

Your role will involve journal scanning, current awareness bulletin production and literature searching, using internal and external on-line databases.

In the course of your work you will be expected to develop close links with scientific staff at all levels; hence good communication skills are essential.

You will be a graduate with a background in organic chemistry or immunology/cell biology with a strong commitment to providing information support to scientific staff. Whereas previous information experience is not essential for either post, relevant research experience would be an advantage for the one involving immunology/cell biology.

The company offers a competitive salary package including participation in Group profitability. Other benefits are a non-contributory pension scheme and excellent sports and social facilities.

Please send a CV or brief details of your career to date to: Mr. R. W. Jones, Senior Personnel Officer, Glaxo Group Research Ltd., Greenford Road, Greenford, Middlesex, UB6 0HE, quoting reference no. AQ/545.

Glaxo *Group Research Ltd.*

NATURAL ENVIRONMENT RESEARCH COUNCIL

RESEARCH VESSEL SERVICES

COMPUTING AT SEA

COMPUTING SYSTEMS ENGINEERS are required to join a team responsible for the development and support of computer systems on the NERC research ships. The systems are based on 68000 and Intel micro-processors. The main operating system is UNIX and all software development is in 'C'. Experience of these in a scientific environment would be useful but not essential and appropriate training will be provided.

Applicants should be qualified in electrical or electronic engineering and/or computer science. They should be able to demonstrate a broad based interest or aptitude in both the engineering and the software aspects of microcomputer development and operation.

Candidates must be prepared to travel and spend time away from home, including periods at sea.

Qualifications/Experience. A degree, HND, HNC or an equivalent qualification in an appropriate subject. A Pass in BCS Part II and relevant experience is acceptable.

Salary Scales. Appointment will be in the grade of Scientific Officer with salary scale of £5682-£7765 pa (under review). The starting salary may be above the minimum depending on qualifications and experience. In addition under the present regulations a Scientific Officer could expect to increase his/her earnings by at least £1500 pa with normal sea-going duty.

The Research Vessel Services operate and maintain several oceanographic research ships, and provide a wide range of instrumentation and computing facilities for the marine research programmes of NERC component bodies and university departments.

Further details and application forms may be obtained from:

Natural Environment Research Council, Research Vessel Services, No 1 Dock, Barry, S Glamorgan CF6 6UZ. Tel Barry (0446) 737451. Closing Date for Receipt of Completed Applications: 2 November 1984

CHEMICAL CONTROL ENTOMOLOGIST

TSETSE PROJECT, SOMALIA

Duties: Under the direction of the project leader, to be responsible for the implementation and evaluation of techniques, both ground and aerial methods of applying insecticides and other methods for the control of Tsetse flies. This will entail studies in the field of the Impact of Control measures on Tsetse flies and any additional studies that may be required to improve the efficiency of the various control methods whilst providing on the job training in Tsetse control to local staff. There will be a need to liaise closely with other project staff and in particular with the other members of the project concerned with studies on Tsetse survey and ecology, environmental monitoring trypanosomiasis survey and research and land use.

Qualifications: Applicants should be British citizens with a good Honours degree in a scientific subject (preferably Biology) or an equivalent qualification and have at least 4 years post graduate experience preferably with field experience in Africa.

Appointment: On contract to the Overseas Development Administration under Technical Co-operation terms until December 1985. Salary (UK Taxable) in accordance with qualifications and experience plus a Variable Tax Free foreign service allowance currently in the range £3,755 - £8,395 depending on marital status.

The post is wholly financed by the British Government under Britain's programme of aid to the developing countries. In addition to basic salary and overseas allowances other benefits normally include paid leave, free accommodation and medical attention.

For full details and application forms please apply quoting ref. AH 309/ER/Y stating post concerned and giving details of age, qualifications and experience to:

Appointments Officer,
Overseas Development Administration,
Room AH 309,
Abercrombie House,
Eaglesham Road,
EAST KILBRIDE,
Glasgow G75 8EA.

ODA

OVERSEAS DEVELOPMENT

BRITAIN HELPING NATIONS TO HELP THEMSELVES

GRADUATE SCIENTISTS FOR MONOCLONAL ANTIBODY RESEARCH

from £8,350 p.a.

Celltech, already the U.K. leader in recombinant DNA and cell hybridisation research and development is going from strength to strength in the biotechnology field.

We are looking for a graduate scientist with two or three years experience to join our immunoassay group. This group develops the immunoassays for biologically active substances that are currently measured by bioassays. In addition we're investigating other novel applications for immunoassays using monoclonal antibodies.

If you have a degree or similar qualification and the right sort of experience, such as with RIA's, ELISA's or antibody purification, you'll find that Celltech can offer you more. Our established market presence puts our research work on a secure footing with the most effective resourcing.

Top salary levels come with substantial benefit support including relocation assistance where appropriate. Send you career details and current salary, quoting reference 234, to Jane Walley,
Celltech Limited, 244-250 Bath Road, Slough, Berks SL1 4DY.

CELLTECH

AGRICULTURAL AND FOOD RESEARCH COUNCIL

FOOD RESEARCH INSTITUTE
Chemistry & Biochemistry Division

BIOCHEMIST/BIOLOGIST

Temporary Higher Scientific Officer
– 15 month appointment

A HIGHER SCIENTIFIC OFFICER is required to set up immunoassays of tricothecenes using methods developed at the Institute. The post, which is financed by a Contract from the Ministry of Agriculture, Fisheries & Food, is temporary and has a maximum term of 15 months.

Qualifications:
A first or upper second class honours degree in Biochemistry or a biological subject and at least two years' relevant postgraduate experience, preferably a PhD degree. Experience with immunoassays desirable.

Salary:
On a scale £7149–£9561 (under review). Non contributory superannuation scheme.

Further information and application form from The Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA, quoting reference 84/34. Telephone enquiries to the Registry (0603 56122 Ext 230).

Closing date: 1 November, 1984.

UNIVERSITY OF ULSTER
Faculty of Science
Department of Environmental Studies

"NEW BLOOD" LECTURESHIP IN FISH BIOLOGY

Ref C047/106

The person appointed will be based at the Limnology Laboratory, Traad Point, Magherafelt, Co Londonderry, to develop research into fish populations, with particular reference to the ecology of Lough Neagh and associated rivers which sustain valuable commercial and sport fisheries.

Applicants should be either fish ecologists or experimentalists seeking answers to ecological problems. As this post has been established under the national scheme to encourage the appointment of younger members of staff, applicants should normally be under the age of 35 years.

Commencing salary will be determined by age, qualifications and experience within the scale £7190 - £14 125 (under review).

Further details are available from the Staffing Officer, University of Ulster at Coleraine, Cromore Road, Coleraine, Co Londonderry, BT52 1SA (telephone Coleraine 4141, ext 568) to whom applications, including a full curriculum vitae and the names and addresses of three referees, should be sent not later than 12 November, 1984.

Scientists

Why not enter Sales?

Salaries
£6500-£8000 Basic
+ Car + Bonus

If you want a career with a future, where you are rewarded according to your effort then consider selling. We have vacancies with major companies in pharmaceuticals, diagnostics and medical/scientific equipment throughout the U.K.

For a local interview to discuss an exciting future ring Sutcliffe Selection 0256 55955, (24 hours) 46/48 Essex Road, Basingstoke, RG21 1TB.

Sutcliffe Selection

THE UNIVERSITY OF ASTON IN BIRMINGHAM

Department of Chemistry

SERC POST-DOCTORAL RESEARCH FELLOW

Synthesis and characterisation of electroactive polymers

Applications are invited from those who wish to work in this exciting new area of polymer science in collaboration with Dr A. J. Amass and Dr M. S. Beevers on the synthesis and properties of block copolymers suitable for use in electronic devices.

The post will be funded by the SERC, for two years in the first instance, as part of the specially promoted programme in electroactive polymers. The commencing salary for immediate appointment will be within the range £7190–£8530 pa (Research range 1A – under review). Informal enquiries may be directed to the collaborators.

Application forms and further particulars may be obtained from the University Secretary (quoting reference 641/32) University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET. (Tel 021 359 3611, Ext 4564). Closing date for the receipt of applications is 9 November, 1984.

UNIVERSITY OF OXFORD
BIO-ENGINEERING UNIT
Department of Paediatrics

RESEARCH FELLOW – IMAGING

Novel methods based on electrical impedance are being developed for continuous imaging of the brain of the newborn infant. A graduate or post-graduate engineer or physicist is required to lead the development of the new algorithms and assist with clinical trials. Familiarity with the mathematics and computer aspects of imaging techniques is important.

The post is supported by Action Research for two years. Salary on either basic grade or senior grade of the Hospital Physicist scales.

Applicants should send their full CV and the names of two referees to Dr P Rolfe, Head of Bio-Engineering Unit, John Radcliffe Hospital, Oxford OX3 9DU.

SECTION HEAD
Analytical Chemistry

THE JOB

Contactasol Ltd is a progressive, fast-growing pharmaceutical company in the field of sterile ophthalmic products including contact lens solutions and has an aggressive policy for new product development.

We have an expanding export function backed by a strong home market.

Manufacture is based at New Malden, Surrey. The position entails:

★ Managing a small Unit responsible for the analysis of raw materials and products.
★ Analytical method development.
★ Experimental work and trouble-shooting related to new product development.
★ As this is a key position within the organisation experience will be gained in the broader aspects of quality assurance.

THE PERSON

A vacancy has arisen for a Graduate in chemistry with an analytical chemistry background and experience in the field of HPLC. The following qualities are required:

★ An energetic person to join a young and progressive management team.
★ The ability to communicate effectively at all levels within the company.

In return we offer a competitive salary and benefits package.

Interested applicants should forward full details to:

Dr G. Davison,
Quality Control Manager,
CONTACTASOL LIMITED,
Unit 2, 161 Kingston Road,
New Malden,
Surrey
Tel 01-949 5616.

Development Biochemist

As part of the programmed growth of the newest UK company within the Fisons Group, we now need to expand our development base by the appointment of a Development Biochemist.

If you have just graduated in Biochemistry alone, or in combination with a second discipline, this is an ideal opportunity for you to join our expanding development department. Reporting to a Senior Biochemist you will be involved in basic research and development of heparin and insulin products, which are made in our Wrexham factory in North Wales.

The company offers an attractive financial package, which includes profit sharing bonus, pension and life assurance and assistance with relocation expenses, where appropriate.

Please write in confidence with full c.v. to: Doreen Sharp, Personnel Officer–UK Operations, Fisons plc, 12 Derby Road, Loughborough LE11 0BB.

Product Development Manager
Animal Health

Cyanamid is a diverse business with interests in the agricultural, pharmaceutical and industrial chemical sectors. Considerable expansion has been enjoyed recently as a result of a vigorous sales and new products programme.

To supplement our existing technical group within the Animal Health Division, we wish to appoint a Product Development Manager to be responsible for the planning, conducting and reporting of experiments with farm livestock and the evaluation of the safety and efficacy of animal health products, Commitment to meet tight deadlines is essential as is the ability to produce concise written reports on the status of assigned products.

Candidates should have a degree or equivalent in agriculture (Animal Husbandry being prefered), be aged 23 – 30 and have had experience of experimental work with farm livestock in the agricultural industry or in an academic environment.

This position will be based at our Head Office in Gosport, although some travelling throughout the UK will be required. Salary and conditions of employment, including a Company Car, are attractive and will incorporate relocation expenses in appropriate cases.

To obtain an application form, please ring our Ansafone service on (0329) 230941 any day after 12 noon.

CYANAMID

GRADUATE TRAINEE INFORMATION/PATENT SEARCHER

Starting Salary £7000+ **LONDON WC2**

Due to business expansion, a leading firm of international Patent Searchers and Translators require graduate scientists and engineers to train as Information/Patent Searchers.

Responsible to the Directors, your work will involve visiting the Patent Office and from time to time various other libraries to examine the relevant literature and obtain the necessary information. On-the-Job training will be given.

Aged up to 30, you must have an eye for accuracy, the ability to write clear, concise and logical reports, preferably read French and/or German, and be able to liaise with people at all levels.

Benefits include free BUPA.

Please write with cv to: Mr. S. J. Lodge,
Woolcott & Co. Ltd.,
Chansitor House,
37/38 Chancery Lane,
LONDON WC2A 1EL.

PRODUCT DEVELOPMENT OFFICER

BA Chemicals Limited a member of the Alcan Group of Companies wishes to recruit a Product Development Officer to work on the introduction of new product lines to its Burntisland plant.

The plant produces a wide range of alumina based products and is always seeking to extend its product line to meet market demands. The Product Development Department is responsible for establishing the correct parameters for each new product and establishing production procedures to make them. Considerable liaison is required between Research, Laboratory and Production Departments.

The job requires technical expertise coupled with the ability to work with people from a number of backgrounds.

Male or female applicants should possess a degree or equivalent in Chemistry, Chemical Engineering, Ceramic or Material Science or related disciplines and should have a number of years experience of working in industry or research.

Career prospects and conditions of employment are excellent and assistance with relocation may be given.

Please write or telephone for an application form to:

Jim Dobbie
BA Chemicals Limited
Burntisland
Fife, KY3 0EP
Telephone 0592 873741

ALCAN

You've worked hard for your Science degree. Now let it work for you!

As a Medical or Technical Representative, you can earn unlimited bonuses in addition to a good basic salary and company car.

If you are ambitious, aged 21-35, you can enter a career offering excellent prospects and a real challenge.

Call us now for details of vacancies throughout the UK and our detailed, informative booklet, on **01-831 6471 or 01-405 0725.**

Scientific Staff Consultants
50 Lincoln's Inn Fields, London WC2

SSC
SCIENTIFIC STAFF CONSULTANTS

The best way to make your science degree pay!

UNIVERSITY OF SHEFFIELD

TECHNICIAN (GRADE 3)

DEPARTMENT OF BIOCHEMISTRY

Technician required to join an active group studying the human monocyte cell surface. Duties will involve raising monoclonal antibodies, general tissue culture work and a wide variety of immunological techniques. Preference will be given to applicants with tissue culture experience. Salary on scale £5399-£6325.

Please write to the Administrative Officer (Personnel), (Ref S1878/NS) The University, Sheffield S10 2TN.

HERIOT-WATT UNIVERSITY

RESEARCH ASSOCIATE IN OFFSHORE PROCESSING

DEPARTMENT OF CHEMICAL AND PROCESS ENGINEERING

A Research Associate is sought for research into offshore processing – especially into the influence of see induced motion on key chemicel engineering unit processes such es seperstion, This topic is of increasing significence in offshore oil snd gss extraction due to the trend towsrds using mobile support structures such ss semi-submersibles snd converted tankers. The successful candidate will join a small but expanding research group supported by SERC snd industry.

Applicants should have e BSc in chemical engineering or other relevsnt engineering or science discipline. The sppointment will be for one yeer in the first instance. Salary will be on the scale £6310-£8530 (under review).

Suitsbly qualified candidates may be able to register for research towards a higher degree.

Applications should be mads ss soon as possible to the **Staff Officer, Heriot-Watt University, Chambers Street, Edinburgh EH1 1MX, quoting reference no. 96/84. Tel. 031 225 8432.**

Informal enquiries may be made to Dr B. Waldie et the same address.

UNIVERSITY OF CAMBRIDGE

Department of Metallurgy and Materials Science

POSTDOCTORAL RESEARCH ASSISTANT IN CONTAINERLESS SOLIDIFICATION OF ALUMINIUM ALLOYS

Applications are invited for the above post, available immediately and tenable for three years, to work on the fundamentals of crystal nucleation and growth in highly undercooled liquid aluminium alloys.

Applicants should have a strong background in physical matallurgy. Experience in rapid quenching and electron microscopy would be an advantage.

Salary will be on the standard SERC scale with USS superannuation benefits. Further information is available from Dr A. L. Greer, Dept. of Metallurgy and Materials Science, University of Cambridge, Pembroke Street, Cambridge CB2 3QZ (Tel 0223 65151). Applications, including a full cv and the names of two referees, should be sent to the above address.

UNIVERSITY OF BRISTOL

Department of Anatomy

RESEARCH TECHNICIAN-GRADE 3

Applications are invited for the post of research technician financed by the AFRC for one year from 1 November. The grant is an extension of a three year support for research into the physiology of relaxin. The work is varied, involving the physiology of reproduction in pigs and sheep, radioimmunoassay of hormones, peptide chemistry and computing. Some experience in one or more of theses subjects would be an advantage. Salary will be in the range £5399 to £6325. Applications, with the names and addresses of two referees, should be sent to Professor D. G. Porter, Department of Anatomy, The Medical School, University of Bristol, Bristol BS8 1TD, from whom further details may be obtained.

ST GEORGES HOSPITAL MEDICAL SCHOOL
(University of London)

RESEARCH ASSISTANT/ RESEARCH FELLOW

For Sleep Laboratory

required by the Psychiatry Department (Professor A. H. Crisp) for three years. The work can be pre- or postdoctoral and an appropriately qualified person with a mixture of skills which includes polygraphic laboratory and computing skills is sought. Salary in the range £7190-£11 615 pa (under review) plus London allowance £1186 pa. Further details and application form from the Establishment Officer, St George's Hospital Medical School, Cranmer Terrace, London SW17 ORE. Closing date 12 November, 1984.

TECHNICIAN

required for the MRC Human Biochemical Genetics Unit, University College London, Wolfson House, 4, Stephenson Way, London NW1 2HE. Good Hons degree or HNC essential. The work will involve analysis of gene products and genes using analytical separation procedures and a variety of biochemical and immunological methods. Previous laboratory experience would be an advantage. Appointment will be to Technician scale. (Salary: £5491-£7747 + £1042 London Weighting). Apply by submitting full cv with two named referres to Dr D. A. Hopkinson.

TRANSNET

LONDON TRANSPORT TECHNOLOGY NETWORK

6 Avonmouth Street,
London SE1 6NX.
Telephone: 01-407 1537

DEVELOPMENT MANAGER

The LONDON TRANSPORT TECHNOLOGY NETWORK is a unique Londonwide agency formed with the support of the GLC's job-creating arm, the Greater London Enterprise Board. LTTN is run by a Council which represents a wide range of community and other interests, to ensure that LTTN's principle role is to promote the development of effective and viable initiatives in the field of transport; these will be expected to contribute both to transport services in the community and to the capital's economy.

The DEVELOPMENT MANAGER is a new post within LTTN. It will be the Council's most senior post, and the person appointed will be responsible to the Council for the Network's performance. She/he will thus have a leading role in the development of LTTN. The specific responsibilities of the Manager will be:

1. Setting up the Network and liaising with member organisations.
2. Day-to-day implementation of LTTN's strategy and the Council's programme and related initiatives.
3. Assessing, supporting and supervising the work of the project workers and of other LTTN staff.
4. Formulating and enacting plans for the further development of LTTN, including identification of sources of external funding.
5. Producing recommendations to Council for further programmes for work to other initiatives.
6. Such other tasks as shall be determined from time to time.

The person appointed to this post must share the aims of LTTN and will need to have a professional and businesslike approach to management. She/he will preferably have worked in the voluntary/co-operative sectors and have some knowledge of trades unions. Prior experience of transport matters is, however, not essential.

The post will be in accordance with local authority terms and conditions on a salary of: £12 000-£14 000 plus London Weighting; 37 hours per week with time off in lieu; and 21 days holidays plus 3 days between Christmas and the New Year.

Informal enquiries concerning this post may be made to 01-407 1537.

Application by letter, with two references, should be received by first post on 29 October.

LTTN IS AN EQUAL OPPORTUNITY EMPLOYER

University of Strathclyde

DEPARTMENT OF PURE AND APPLIED CHEMISTRY

TEMPORARY LECTURESHIP

Applications are invited for a temporary lectureship, tenable for three years, in Physical Chemistry. The successful candidate will be expected to interact with existing research groups in solid State Chemistry, Polymer Chemical Physics, Surface Chemistry and Laser Chemistry as well as contributing to the teaching programme.

Salary on scale for Lecturers (£7190- £14 125 pa). USS benefit.

Application forms and further particulars (quote Ref: 58/84) are available from Staff Office, University of Strathclyde, McCance Building, 16 Richmond Street, Glasgow G1 1XQ.

Closing date for applications: 26 November, 1984.

EDITORIAL MANAGER

UNICOM SEMINARS have been established to follow the developments in the rapidly growing field of computer software and information technology. Our purpose is to disseminate information and develop awareness of research findings, market information and the state of the art in this important industrial sector. We are now seeking an editorial manager who will play a key role in our development plans. The ideal person would have worked as a commissioning editor and have an interest in promotion as well as production of academic volumes. The job provides scope for involvement in all aspects of the business such as marketing of the seminars, preparation of brochures, drawing up contracts, preparation of financial budgets, design and production of monographs. Previous experience in information technology is not essential.

This is an ideal opportunity to join a young dynamic company in an exciting field.

Apply in writing enclosing a CV to **Dr Gautam Mitra, UNICOM SEMINARS, 108 Kew Road, Richmond, Surrey TW9 2PQ.**

Production Technicians

We are a division of the major multi-national pharmaceutical Company G.D. Searle and Co. Ltd. At our modern factory in Morpeth we manufacture a range of ethical and consumer products for both home and export markets.

We are currently expanding our chemical manufacturing facilities and we are now seeking two production technicians to assist in the running of these new facilities. Responsibilities will involve direct production work as well as a certain amount of production monitoring and implementation of improvements and developments to processes.

Candidates should be educated to HNC or degree level in Chemistry or Chemical Engineering and should have some previous experience either of chemical production work or of chemical development work in an industrial laboratory. Both positions will be based on the factory's double-day shift system.

A competitive salary will be offered together with a shift allowance and a comprehensive range of benefits.

**For an application form please contact:
John M. Ross, Assistant Personnel Manager, Searle Pharmaceuticals,
Whalton Road, Morpeth,
Northumberland NE61 3YA.
Tel: Morpeth 514311.**

SEARLE

LONDON BOROUGH OF ISLINGTON
Recreation Services Department

CONSERVATIONIST GARDENER GLJC 'G'

(£108·09 per week + bonus)

Applications are invited from persons with specialist knowledge of ecology and wildlife conservation as applicable to urban areas to manage a four acre site in Islington.

The possession of City and Guilds Horticulture Phase II or equivalent is essential and a minimum of one year's practical experience of horticultural work would be an advantage as would the possession of a current British driving licence.

Applicants must be able to demonstrate a sound horticultural knowledge with particular emphasis on wild plants, pond life, birds and insects. As there is a strong link with schools, the ability to provide interpretative material and involve people of all ages in the site is also essential.

For application form and further information, telephone 24 hour answering service on 01-607 2985. Closing date Friday, 2 November 1984.

Applications are welcome from candidates regardless of race, sex and sexuality and we have a positive attitude towards the employment of disabled people.

NEWCASTLE UPON TYNE POLYTECHNIC
FACULTY OF ENGINEERING
School of Materials Engineering

RESEARCH ASSOCIATE

Researcher 'B' - £7548 - £10 251
Ref. No. RA8/84

Part-externally funded post, to undertake studies concerning corrosion/degradation of engineering ceramics with particular reference to silicon nitride in sulphidising environments. Sponsors are Joint Research Centre, Petten & The Polytechnic.

Candidates should be well qualified in engineering or science discipline, possessing higher degree.

Appointment initially for one year – anticipated extension of a total period of three years.

Further details, application form returnable 2 November, 1984, from Linda Morris, Admin. Asst. (Recruitment), Ellison Building, Ellison Place, Newcastle upon Tyne. Please quote Ref No.

Medical Information Officer

South Manchester

Stuart Pharmaceuticals require a Medical Information Officer to work in its headquarters in South Manchester.

Previous experience in Medical Information work is essential and the successful candidate is likely to have a good biological science degree and detailed knowledge of either antimicrobial or cardiovascular drugs. He/she will also have a demonstrable ability to communicate fluently in writing and by telephone with Company staff and customers at all levels.

The post will involve the technical servicing of the Company's customers, direct liaison with clinicians involved in clinical trials work and the preparation and presentation of reports and technical literature. The job holder must maintain a high level of awareness of research literature and will be expected to attend symposia in areas of the Company's interest.

Starting salary c.£13,000 per annum plus excellent conditions of service.

Write with full personal and career details to:
Mrs J M Maynard,
Stuart Pharmaceuticals Ltd,
Carr House, Carrs Road,
Cheadle, Cheshire SK8 2EG.

CHARING CROSS AND WESTMINSTER MEDICAL SCHOOL

(University of London)

Department of Biochemistry

RESEARCH TECHNICIAN

Applications from those with experience in histological techniques are invited for the above post. The project is a multidisciplinary study of cholinergic pathways in the central nervous system. The post is on the MLSO scale, £5738-£8096 pa plus £1042 pa London Weighting Allowance, and is tenable for a period 18 months.

Applications on forms obtainable from The Secretary, Charing Cross and Westminster Medical School, The Reynolds Building, St Dunstan's Road, London W6 8RP, Tel 01-748 2040, Ext 2067, to be submitted within three weeks of the appearance of this advertisement.

KING'S COLLEGE SCHOOL OF MEDICINE & DENTISTRY

of King's College London
Denmark Hill London SE5 8RX

An embryologist is required to join a research team studying biochemical and morphological changes in pre-implantation embryos. Previous experience in hybridisation histochemistry or immunohistochemistry would be an advantage. Salary to be discussed. Applications including a full a cv and names and addresses of two referees, should be sent to the Secretary of the School at the above address by 1 November, 1984.

SOFTWARE & HARDWARE DESIGN

£8,000-£20,000

PLUS GENEROUS RELOCATION

DORSET, HAMPSHIRE, SUSSEX
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If you can offer Phd. or M.Sc. or B.Sc. or HNC/D in Electronics, Physics or Mathematics with a minimum of one years experience either in Software or Hardware Design we would like to discuss stimulating design career opportunities in . . .

C3, SATELLITE & MILITARY COMMUNICATIONS, RADAR, SONAR, AVIONICS, ATE, CAD, DATA COMMUNICATIONS etc.

SOFTWARE DESIGNERS

PDP or VAX or HP or DG or GEC experience needed or 8085/86/88 or Z80 or 6800 or 1802 experience using one or more of CORAL, PASCAL, ADA, ASSEMBLER, FORTRAN, RTL2, PLM, ALGOL, C or MACRO . . .

HARDWARE DESIGNERS

Sound Digital and or/analogue experience please -some microprocessor knowledge is advantageous.

WE ALSO WISH TO RECRUIT

MATHEMATICIANS, MATHEMATICAL MODELLERS, TRIALS ENGINEERS, QUALITY ASSURANCE ENGINEERS, OPERATIONAL RESEARCHISTS, RF & MICROWAVE DESIGN ENGINEERS . . .

Phone or write today

CBS APPOINTMENTS

1 Wootton Gardens, Bournemouth
0202 – 292155 (24 hours answering)
Evenings 04254 – 70379 (Agy)

UNIVERSITY OF WALES COLLEGE OF MEDICINE

Department of Pathology

UNIVERSITY TECHNICIAN

Applications are invited for the post of University Technician to work on immunocytochemical problems. The department has a wide experience in immunofluorescence, immunoenzyme and immunogold techniques, and has developed electronmicroscope immunocytochemistry. Experience in conventional histological methods required, immunocytochemical experience advantageous, but not essential.

Salary within the range £5399-£7684 pa with starting point and scale dependent upon qualifications and experience.

Application forms (quoting Ref No P4A) available from the Registrar and Secretary, University of Wales College of Medicine, Heath Park, Cardiff CF4 4XN (Tel 0222/755944 Ext 2296). Closing date for application two weeks from the appearance of this advertisement.

UNIVERSITY OF EXETER

Department of Geography

POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for the above post to work with Dr D. E. Walling on a NERC-funded investigation of drainage basin sediment delivery processes and the linkages between on-site erosion and down stream yield. The appointment will be for two years from 1 January, 1985. Starting salary £7190 pa (under review).

Applicants should have, or be about to complete a Higher degree in Physical Geography or a related Environmental Science discipline and should possess an interest in catchment research.

Further particulars may be obtained from Dr D. E. Walling, Department of Geography, University of Exeter, Exeter EX4 4RJ to whom letters of application providing full personal details and the names of two referees should be sent to arrive not later than Friday, 9 November, 1984.

UNIVERSITY OF BRISTOL

Department of Veterinary Medicine

GRADE 5, CLINICAL VETERINARY LABORATORY TECHNICIAN

Applications are invited for an experienced Clinical Laboratory technician to work on a variety of domestic animal species for a two-year period in the first instance. The position carries responsibility for routine clinical biochemistry and haematology with greater emphasis on haematology.

Starting Salary: £6581

Applications with names of two referees by 14 November, 1984 to Professor F. J. Bourne, Department of Veterinary Medicine, Langford, Bristol BS18 7DU.

PROFESSORSHIP OF INFORMATION ENGINEERING

The electors intend to proceed to an election to the newly established Professorship of Information Engineering. The stipend of the professor will be £19 880 pa (under review).

Applications (ten copies, or one from overseas candidates), naming three referees but without testimonials, should be received not later than 14 December, 1984, by the Registrar, University Offices, Wellington Square, Oxford OX1 2JD, from whom further particulars may be obtained.

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eastern electricity

Technology Transfer Specialists

Applications are invited for two posts in the newly created Technology Transfer Unit based at our Headquarters near Ipswich.

The Unit will comprise of a small team of specialists responsible for identifying fresh applications for existing technology and for developing new or advanced technology for industry. It will provide a high level of technical assistance and specialist advice in a wide range of applications, products and processes, and be responsible for liaison with research establishments, industry, universities and colleges.

The successful applicants—who will be experienced and qualified engineers with either an industrial, research or marketing background—will work initially in one of the following areas:-

(a) electrochemistry and food processing technology.

(b) process heating, particularly metal melting, heat treatment and surface treatment.

These posts offer an exciting challenge and an opportunity to play a major part in our drive for growth in electricity sales through the encouragement of industry and commerce to become more competitive and energy efficient by making wider use of existing and advanced technology.

Salary: Within the range £13 584 to £17 153 dependent upon qualifications and experience.

Please apply in writing giving full details of career to date to the Director of Marketing, Eastern Electricity, PO Box 40, Wherstead, Ipswich, Suffolk IP9 2AQ, by 1 November, 1984.

Eastern Electricity is an Equal Opportunity Employer

Physics Trust Publications

PUBLICATION RESEARCH & DEVELOPMENT ASSISTANT

Physics Trust Publications, the publishing division of The Institute of Physics, is committed to developing its programme of publications and other services to meet the present and future needs of the physics community. Applications are sought for this post, which supports the Editorial Director by providing the research and administrative services necessary for the division's development programme.

The person selected will have a science degree and some postgraduate, preferably publishing, experience; some acquaintance with computing/communications will be an advantage.

Application forms should be requested from the **Office Manager, The Institute of Physics, Techno House, Redcliffe Way, Bristol BS1 6NX (telephone 0272 297481).**

The closing date for receipt of applications will be 2 November, 1984.

ICI

IMPERIAL CHEMICAL INDUSTRIES PLC
ELECTRONICS GROUP

MATERIALS SCIENTIST/PHYSICIST

For the development and characterisation of highly filled polymers. The successful candidate will set up and run facilities to measure magnetic/electrical properties as appropriate and help optimise the desired properties by modification of material composition/processing. Ideally you would have experience of particle technology, powder handling or ceramic processing. You should also have a degree in materials science or physics or equivalent, an interest in measurement techniques and an ability to work independently.

Electronics Group was created in May 1983 to identify, develop and exploit opportunities in the electronics industry. Strong emphasis is placed on gaining business beyond the sale of chemicals by downstream integration through joint ventures and acquisitions, and by close cooperation with the electronics industry. Key areas are seen as opto-electronics, data storage, and interconnect technology.

Salary up to £13 000 depending on age and experience.

Closing date 1 November, 1984.

Please apply in writing enclosing full CV to

Miss E. H. Lauermann, Personnel Officer
PO Box No 11, The Heath, Runcorn
Cheshire.

Battelle
Geneva Research Centres

Our centre for Toxicology and Biosciences wishes to expand its Drug Kinetics and Analytical Chemistry Section with two

PhD RESEARCH SCIENTISTS

One should have at least two years postdoctoral experience in metabolism and pharmacokinetics, preferably in an industrial environment. The applicant should have a broad knowledge of techniques with radiolabelled and cold drugs. Experience with human studies and an interest in biostatistics would be an advantage.

The second scientist should have at least three years postdoctoral experience in the analytical chemistry of drugs of foreign compounds. The applicant should have a sound knowledge of modern techniques and be able to develop methods for new compounds.

Applications with a full curriculum vitae, photograph, salary requirements and indication of proficiency in French should be addressed to: Personnel Manager, BATTELLE, 7, route de Drize, CH – 1227 **Geneva/Switzerland.**

Physicists/Physical Chemists

Innovative problem solvers for 'real world' advances

Work at Philips Research Laboratories, Redhill, is part of an international effort aimed at investigating and developing state of the art processes and technologies essential to the progress of one of the world's major research orientated organisations.
At present we have important openings in a key area offering unrivalled scope for personal and career development at the frontiers of knowledge.

Thin-film Transistors and Liquid Crystal Displays

There are posts for scientists preferably with post-doctoral experience of research into the physics of devices or the physical chemistry of materials and processes. The research is a vital part of a new project on actively-addressed LCD's and will involve investigation of the fundamental and practical factors determining the performance of large-area LC displays.
In addition to a salary and career structure geared to the recognition of personal commitment and contribution, our working conditions and facilities are designed to stimulate effective research.
Please write with career details to Mrs. D. Lloyd, Personnel Department, Philips Research Laboratories, Cross Oak Lane, Redhill, Surrey or telephone Horley (02934) 5544 for an application form.

Together we can shape the future

PHILIPS Research Laboratories

PHILIPS

ROYAL POSTGRADUATE MEDICAL SCHOOL
(University of London)

Department of Chemical Pathology

TECHNICIAN

required to work on an MRC supported project involving the development and practice of radioimmunoassays and enzyme-linked assays and may involve some aspects of cell pathology and molecular biology. The Technician should have appropriate training and experience and be qualified to HNC level.

Starting salary will be up to £6500 plus £1042 London Allowance and will be for three years supported by a grant from the Medical Research Council.

Application forms and further particulars can be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Du Cane Road, London, W12 0HS, quoting reference number 4/231.

Closing date: 8 November, 1984.

UNIVERSITY OF LONDON

INSTITUTE OF NEUROLOGY

Applications are invited for the position of Research Assistant (Range 1B) to join a group studying nerve-muscle interactions and gene expression in the developing spinal cord. Background in protein chemistry or molecular biology would be an advantage.

Applications including full cv and names of two referees to Dr F. S. Walsh, Institute of Neurology, Queen Square, London WC1N 3BG as soon as possible.

Horticultural Engineering Division

PHYSICIST/ RESEARCH ENGINEER

The application of quantitative physical science is now becoming a vital part of the drive for greater efficiency and energy conservation in the horticultural industry.

Ar NIAE, classical optics and thermodynamics are being used in models of greenhouse performance that explore new theoretical concepts, and assess practical engineering applications. We offer an opportunity for a physicist or research engineer to contribute to this new area of science, in the field of greenhouse light transmission. The work will include the construction of computer models to assess the performance of greenhouse shapes and cladding materials, and will lead to the design of a new greenhouse optimized for plant performance.

Applicants must have a degree in Physics or Engineering preferably with experience. Salary in the range £6259 - £7858 per annum according to experience.

Non-contributory superannuation scheme.

Further details and application form from the Personnel Officer, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedford MK45 4HS. Telephone (0525) 60000. Ref: 20/5

1984

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

NIAE

ROYAL HOLLOWAY AND BEDFORD COLLEGES

GEOGRAPHY DEPARTMENT

Workshop/Laboratory Technician required for construction and maintenance of equipment. Familiarity with laboratory instruments and workshop techniques desirable.

Laboratory Technician required in the physical geography laboratories. Experience in preparation and analysis of soil, rock and plant samples (especially in particle-size and major and trace element work) is desirable.

Salary scale £5899–£6825 a year. These posts are based at Regent's Park, London for one year and then at Egham.

Applications giving details of age, experience and qualifications together with the names and addresses of two referees should be sent to Mrs A. J. Overington, Administrative Officer Personnel, Royal Holloway and Bedford Colleges, Egham Hill, Egham, Surrey, TW20 0EX.

CITY OF LONDON POLYTECHNIC

TECHNICIAN GRADE 3

DEPARTMENT OF BIOLOGICAL SCIENCES

£6600-£7500

Applications are invited to fill a vacancy of Technician Grade 3 in our Department of Biological Sciences which is located in a building in Old Castle Street, London E1, close to Aldgate and Aldgate East Underground Stations.

Main duties will involve assistance with the servicing of Biochemistry and Microbiology practical classes.

Candidates must have 3-5 years experience (including training period) and be qualified to at least ONC, OND, Ordinary C & G, TEC Certificate or Diploma.

Salary is on a seven point scale from £6650 pa to £7577.

For further particulars and an application form please write on a postcard to the Staff Records Officer, City of London Polytechnic, 117 Houndsditch, London EC3A 7BU, quoting reference 84/60.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE
(University of London)

Department of Neurological Science

JUNIOR TECHNICIAN

Junior Technician required to join a group of basic and clinical scientists studying autoimmune muscle diseases. This post is primarily to help in immunohistological research on thymus (and muscle) in myasthenia gravis.

Previous interest in, or experience of, histology would be an advantage.

The post is available immediately until 30 September, 1986 and is funded by the Muscular Dystrophy Group of Great Britain.

Further details and application forms available from the School Office, RFHSM, Rowland Hill Street, London NW3 2PF (01-794 0500 Ext 4276).

Closing date 26 October, 1984. Please quote Reference JT/MDG/NS.

UNIVERSITY OF WARWICK

RESEARCH FELLOW-NMR

To work on a SERC supported project involving the application of Magic Angle Spinning NMR to structural studies of solids. Applicants should have, or soon expect to complete, a PhD degree involving NMR. The appoinment will be for one year, initially on the Research 1A scale: £7190-£8080 (under review). Further information may be obtained from Dr. R. Dupree, Physics Department, University of Warwick, Coventry CV4 7AL to whom applications containing a full cv and the names of two referees should be sent as soon as possible.

Velindre Hospital, Whitchurch, Cardiff

Radiotherapy Physics Unit

Senior Physicist

Required for a small unit providing a nuclear medicine service to a busy Radiotherapy and Oncology Department.

Main equipment – IGE Maxicamera II.

Collaboration with other sections is encouraged and, therefore, a knowledge of electronics and/or computing is desirable.

Applicants should possess a good honours degree and at least four years relevant experience.

N.H.S. Conditions of Service apply.

Salary Scale (under review) £9010 - £11 649 pa.

For further details contact Dr W. H. Sutherland, (Chief Physicist) or Mr N. M. Procter, (Principal Physicist) on Cardiff (0222) 615888.

Application Forms and Job Description from the Hospital Administrator, Velindre Hospital, Velindre Road, Whitchurch, Cardiff CF4 7XL. (Please enclose SAE.)

Closing Date: 2 November, 1984.

SOUTH GLAMORGAN
Health Authority

THE ROYAL SOCIETY OF CHEMISTRY

PRESS AND PUBLICITY OFFICER

The Royal Society of Chemistry is the professional society for chemists in the UK with a membership of 40 000. A Press and Publicity Officer is required to launch and administer publicity campaigns which educate and inform the public about the importance of the science and profession of chemistry to society. Reporting to the External Relations Officer, the successful candidate will establish and maintain contacts with the media, and advise them about chemistry. He/she will also assist in the production of the RSC staff newsletter.

Candidates, aged 25 plus, should be of graduate or equivalent status, and preferably hold qualifications in PR or journalism. At least three years PR or journalistic experience is required, and although no formal qualifications in chemistry are necessary, a proven interest in science is expected.

Salary will be negotiable from £10 416 pa, according to age and experience.

For further details and an application form, contact: **Mrs S. Durham, Assistant Personnel Officer, The Royal Society of Chemistry, 30 Russell Square, London WC1B 5DT. Tel 01-631-1355.**

Closing date for applications is 5 November, 1984.

An Foras Talúntais/A.I.B.

RESEARCH POSITIONS IN BIOTECHNOLOGY

An Foras Taluntais (The Irish Agricultural Research Institute), with the support of Allied Irish Banks, is expanding its programme in Food Biotechnology at its Moorepark Research Centre, Fermoy, Co Cork and seeks applications for the following positions:

A. Molecular Geneticist

B. Protein Chemist

The molecular geneticist is required to join a team engaged in a study of the molecular biology of industrially important lactic acid bacteria and will initiate the development of cloning and expression systems for these bacteria. A PhD in Molecular Biology or equivalent together with experience of modern genetic engineering techniques is essential.

The appointee in protein chemistry will have specific responsibility for development of large scale chromatographic procedures for fractionation of milk proteins. The successful candidate is likely to have a PhD in Biochemistry with practical experience of general techniques of protein chemistry/enzymology.

Both appointments will be on a five-year contract basis. Applications giving full details of qualifications and experience to date and stating which position is being applied for should reach Personnel Department (Ref MB), An Foras Taluntais, Headquarters, 19 Sandymount Avenue, Ballsbridge, Dublin 4, before 5.00 pm on Friday, 9 November, 1984.

OXFORD CITY COUNCIL

Department of Engineering and Recreation

Chargehand Countryside Ranger

Required to lead a small gang in the newly created rural countryside conservation team in Oxford. The post will be based at Shotover Country Park but will involve work at other sites within the City.

Applicants should have experience in a range of countryside management techniques as well as possessing sufficient ecological knowledge to assist with public guided tours. Supervisory experience would be advantageous.

Weekly wage between £111 - £119 per week (including bonus) according to age, qualifications and experience.

Housing accommodation may be available and removal and disturbance expenses up to £1750 will be paid.

Application forms and further particulars available from the Personnel Officer, 35 Queen Street, Oxford OX1 1EF. Telephone Oxford 249811 ext. 465 or 361. Closing date Friday 2 November, 1984. Applications are welcome from all, regardless of sex, marital status, race or disability.

Information Assistant

This interesting and varied post is an excellent first appointment from which to pursue a career in the National Health Service. The successful candidate will be given the opportunity to use their own initiative and assume a certain degree of responsibility. A high level of numeracy is essential for this post, as is the ability to present information clearly. As the post is based in the Information Unit in the District Health Authority's Headquarters (at Rikenel) which has its own computer facilities, a knowledge of computing would be an advantage.

SALARY: £4897 rising by annual increments to £5925

Application and job description forms are available from:

District Personnel Officer
Wotton House
Horton Road
GLOUCESTER
Tel: Gloucester 25288
Closing date:
1 November, 1984

GLOUCESTER
HEALTH AUTHORITY

BANC

British Association of Nature Conservationists

LOCAL AUTHORITIES CONSERVATION RESEARCHER

BANC require a self employed researcher to undertake a study into the performance of local authorities with respect to nature conservation. The study is funded by the World Wildlife Fund and will be supervised jointly by BANC and WWF. Completion period – six months: fee – ca £3000 (+ small expenses budget).

Expertise in nature conservation and experience of work in local authorities an advantage. Own transport and telephone desirable. BANC member preferred.

Applications; send a brief CV and a proposal (max. 300 words), describing how you might approach the project, topics requiring investigation etc. and a SEA to: **Project Organiser (B), BANC/WWF, 3 Church Cowley Road, Oxford.**

Closing date: 1 November, 1984.

Medical Journalist

PULSE, the leading medical newspaper, has a vacancy for an experienced science journalist to help edit its clinical section - which aims to keep family doctors up-to-date on all the latest medical developments relevant to their daily work.

This is a job which provides tremendous scope. As well as commissioning and editing specialist articles you'll be writing clinical news and review articles.

An attractive salary is negotiable and there are excellent career prospects. Other benefits include: five weeks' holiday rising to six with service, contributory pension scheme, free life assurance, and a subsidised staff luncheon club.

If you have an appropriate science degree and are already making your mark in journalism, write to Howard Griffiths, Editor, PULSE, Morgan-Grampian House, 30 Calderwood Street, London SE18 6QH.

The Company is an equal opportunities employer. Employment terms are embodied in an agreement between the Company and the N.U.J.

MG

ST. BARTHOLOMEW's HOSPITAL MEDICAL COLLEGE

DHSS DEPARTMENT OF TOXICOLOGY

Senior Technician or Technician in Haematology

Salary Scale £6780 pa to £10 977 pa inclusive of London Weighting

This is a new post in a growing Department. It carries responsibility for routine work in a variety of species and is likely also to involve experimental studies and method development.

There is a requirement from time to time to help with clinical biochemistry and other laboratory work.

Broad experience and an appropriate qualification are essential. There may be an opportunity to work for a further qualification. The grade and salary will depend upon experience and qualifications.

Applicants should send a full CV and the names of two referees to the Secretary, St. Batholomew's Hospital Medical College, West Smithfield, London EC1.

Closing Date: 29 October 1984.

Data Base Controller/ Programmer

An opportunity exists for a highly motivated Computer or Information Science graduate to manage and expand a large experimental data base on HP1000 type equipment using PASCAL.

The data base requires rapid recall facilities and analysis of data, using some existing software together with additional programmes that must be developed. The ideal applicant must therefore have knowledge of PASCAL and data management systems, together with good communication skills and the ability to interface with professional engineers within a multi-disciplinary team.

A good salary, BUPA and other benefits accompany this unusual opportunity for career advancement.

For further information contact the Personnel Manager, ERA Technology Limited, Cleeve Road, Leatherhead, Surrey KT22 7SA, quoting reference 35/73.

ERA TECHNOLOGY

HAMPSHIRE COLLEGE OF AGRICULTURE

Sparsholt **Winchester**

FISHERIES TECHNICIAN

Salary: £4959-£5493 (pay award pending)

A technician is required to service the Fishery Management Department of the College. Duties to include the preparation of materials for laboratory classwork and demonstrations, the maintenance of the College fish rearing facilities and experimental fish husbandry. This is a post calling for a considerable degree of self-reliance.

Qualifications HNC in Applied Biology or equivalent, experience of fish husbandry and a full driving licence.

Application forms and further details from the Principal. (Tel Sparsholt 441)

CHAM

Consultants in Fluid Flow Heat Transfer and Combustion

CHAM specialises in the computer modelling of engineering and environmental processes involving fluid flow, heat transfer and combustion. CHAM's customers include major industrial and research organisations in the UK, Europe, North America and the Far East.

CHAM requires staff well trained in relevant physics, able to use and develop FORTRAN computer programs, and to formulate and execute projects under commercial pressures.

Applications are invited from graduate engineers and applied scientists for project engineer vacancies. Relevant post-graduate experience or qualifications are desirable but not essential. Top-class salaries offered, and benefits include a non-contributory pension scheme.

Applications please, with full CV's to:

Mr N. Rhodes, CHAM Limited, Bakery House, 40 High Street, Wimbledon, London SW19 5AU, or telephone: 01-947 7651

UNIVERSITY OF SURREY
Departments of Mathematics and Electronic and Electrical Engineering

RESEARCH FELLOW IN MATHEMATICAL MODELLING OF WAVE PROPAGATION

Applications are invited from suitably qualified applied mathematicians and theoretical physicists for the post of Research Fellow to study the modelling and computer simulation of EM wave propagation in inhomogeneous guided wave optical structures. Previous experience in the fields of the mathematical theory of wave propagation and numerical analysis would be an advantage.

The post is for one year in the first instance and the starting salary will be up to £9425 pa (under review) according to age, qualifications and experience with superannuation under USS conditions.

Applications in the form of a curriculum vitae (three copies) including the names and addresses of two referees should be sent to the Personnel Office (JLG), University of Surrey, Guildford Surrey, GU2 5XH by 9 November, 1984, quoting reference 325/NS. Further particulars for this post are available from the above address or by telephoning Guildford 571281 Ext 452.

THE SCHOOL OF PHARMACY
University of London
Toxicology Unit/Pharmacology Department

GRADE 3 TECHNICIAN

required to assist in undergraduate practical classes and the research work of this Unit. Experience in biochemical techniques essential and knowledge of histology, tissue culture or toxicology desirable. ONC, GCLI 735 Pt 2 or equivalent, with three-five years' experience.

Salary £6649-£7575, inclusive of London Weighting. Five weeks' holiday plus public holidays. Season ticket loan.

Applications in letter form, with cv and names of two referees to: Personnel Officer, The School of Pharmacy, University of London, 29 Brunswick Square, London WC1N 1AX. Closing date 31 October, 1984. Applications will not be acknowledged unless invited for interview but final decision will be made known to all applicants.

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No extra-curricular activities; competitive remuneration package. Please telephone: 01-581 7941.

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ZOOLOGIST, age 23, BSc 2(i), specialised in parasitology, interested in entomology, seeks employment. UK or abroad. Box No D826.

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START AN IMPORT/EXPORT AGENCY from home. Exploiting your skills without capital or risk. Send 17 pence stamp. Impex Science Ltd, PO Box 334, London W5.

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RESEARCH

Science Studies and Science Policy Programme

The Economic and Social Research Council is launching a programme of fundamental work on science studies, including a first phase of substantive research to be carried out over three years from Autumn 1985. This will form part of a wider programme of science policy work over the same period. The aim is to develop the existing wide range of approaches within UK science studies. The field includes the activity, organisation, funding or application of the natural and social sciences. Although ESRC may later identify priorities and linkages within the programme, it will be deliberately pluralistic in character.

Researchers in British universities, colleges and research institutes are invited to send in outline proposals (maximum 1000 words) by **30 November 1984**. Further details can be obtained from ***Chris Caswill, ESRC, 1 Temple Avenue, London EC4Y 0BD,*** to whom enquiries and outline proposals, based on pages 3-6 of the ESRC Research Proposal form, should be addressed.

ESRC
ECONOMIC AND SOCIAL RESEARCH COUNCIL

pcl

Faculty of Engineering and Science
Full-time MSc Course in

Microelectronics and Communication Systems

The Polytechnic of Central London is offering a new full-time postgraduata course in Microelectronics and Communications Systems The course, starting in January 1985, emphasises the practical skills required in modern electronic system design using microelectronics technology Considerable use will be mada of PCL's computer-aided design and simulation software The course is open to engineering graduates and numerata scientists from complementary disciplines Students completing the coursa will be experienced in the latest approaches to silicon systems implementation, vital to the Information Technology industry SERC studentships ara available for applicants with good honours degrees

Further details and application forms from The Registry, Faculty of Engineering and Science, PCL, 115 New Cavendish Street, London W1M 8JS
Tel 01-486 5811 exts 6234 & 6239

This course is offered subject to CNAA approval

The Polytechnic of Central London

ARTIFICIAL INTELLIGENCE

A Weekend Seminar at
Middlesex Poly, London
17 & 18 November, 1984

Topics covered include:

- natural language processing
- machine learning strategies
- computer vision and speech
- knowledge-based systems

The news about machine intelligence that appears in the computer press is only the tip of an iceberg of unexploited possibilities. This seminar provides an apportunity for computing professionals to learn about developments at the frontiers of information technology.

For full details write to: Steve Torrance, Intellect Seminars, 65 Gillespie Road, London N5 1LH. Phone: 01-226 0818.

STUDENTSHIPS

THE UNIVERSITY OF ASTON IN BIRMINGHAM
Research studentship sponsored by the 3M company, in the study of mechanisms of wear and associated electronic and magnetic degeneration of computer diskettes. The studentship leading to the degree of PhD carries an annual grant of £3300 with full tuition fees.
Applicants with at least an upper second class degree in physics or an appropriate engineering subject contact: J. L. Sullivan, Department of Physics, University of Aston, Gosta Green, Birmingham B4 7ET. Tel 021-359 3611 Ext 5255.

University College of North Wales, Bangor

SERC Research Studentship

Applications are invited from graduates with a good honours degree in an appropriate subject for a studentship on "The genetics of plant pathogenic *Phytophthora* spp".

Enquiries and applications to Dr D. S. Shaw, School of Plant Biology, U.C.N.W., Bangor, Gwynedd LL57 2UW. Closing date: 31 October 1984. Telephone number Bangor (0248) 351151, Extension 292.

UNIVERSITY OF NOTTINGHAM
Chemistry Department
AN SERC QUOTA RESEARCH STUDENTSHIP
leading to the degree of PhD is available with Professor G. Pattenden, beginning immediately, but not later than 1 January, 1985.
The successful candidate will work in the area of target orientated natural product synthesis, with a particular emphasis on the development of radical initiated cyclisation processes.
Applicants, who must hold a First Class or Upper Second Class Honours Degree in Chemistry, should contact Professor G. Pattenden, Chemistry Department, The University, Nottingham NG7 2RD, as soon as possible. Informal enquiries may be made by telephone (0602 56101, Ext 2407).

SERC CASE STUDENTSHIP

Development of Superconducting Nuclear Particle Detectors

An SERC CASE award is available in collaboration with AERE, Harwell. The research will involve the development of high sensitive nuclear particle detectors based on the detection of non-equilibrium superconductivity with superconducting tunnel junctions. The studentship is tenable for three yeers and the successful applicant will be registered for the D.Phil degree. Prospective candidates should contact Dr. N. E. Booth, Department of Nuclear Physics, Keble Road, Oxford, OX1 3RH at the earliest opportunity.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

THE CITY UNIVERSITY
School of Electrical Engineering and Applied Physics
Measurement and Instrumentation Centre

SERC POST-DOCTORAL RESEARCH FELLOWSHIP

Measurement of Temperature using Optical Fibre Sensors

Applications are invited for the above post in the School of Electrical Engineering and Applied Physics. It will involve work on an SERC sponsored project to investigate and develop temperature sensors using fibre optical means.

Applicants should hold a good honours degree in Physics, Electrical Engineering or a related subject. They should have a doctorate, or expect to obtain one in a relevant field of study. Preference will be given to candidates with some experience of lasers, optics, optical fibres or signal processing.

The post is initially for one year, with the expectation of renewal for a further two years. Salary will be on the scale £8376 to 9266 pa (under review), including London Allowance.

For further details, please contact Dr K. T. V. Gratton, Physics Department, The City University, London, EC1V 0HB. Tel 01-253-4399, Ext 4416, as soon as possible.

UNIVERSITY OF ESSEX

Department of Biology

PHYSIOLOGY OF SULPHATE-REDUCING BACTERIA

Applications are invited from suitably experienced microbial biochemists for a two-year Post-Doctoral Fellowship to investigate, in collaboration with Shell Research, Sittingbourne, the enzyme systems of the sulphate-reducing bacteria. Previous experience in enzymology is essential, and experience with anaerobic bacteria would be an advantage. Appointment will be on Range IA £7190–£11 615 pa (under review), depending on age, qualifications and experience.

Informal enquiries may be made to Dr D. B. Nedwell, Department of Biology, Tel (0206) 862286 Ext 2427.

Applications (three copies), including a cv and the names and addresses of two referees, should reach the Registrar (R/215/NS), University of Essex, Wivenhoe Park, Colchester CO4 3SQ, from whom further particulars may be obtained, by 8 November, 1984.

CLARENDON LABORATORY UNIVERSITY OF OXFORD

Post-Doctoral Fellowship

Applications are invited for a research post to work on Raman scattering and luminescence of superlattices. Experience with semiconductors or with optical properties of solids is desirable. The appointment is initially for a period of two years and the salary will be on Research 1A scale £7190-£9875 pa (under review). Applications, with the names of two referees, should be sent to Dr W. Hayes, **Clarendon Laboratory, Oxford, OX1 3PU.**

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ARIADNE

HOW much truth there is in the story I do not know, but it is said that once there was a farming journal that proposed to publish a picture of a prize-winning bull. However, the proprietor of the journal had a wife who was a powerful character and had some say over the contents, including pictures. The portrait of the bull offended her susceptibilities for it showed the primary sexual apparatus of the beast, naturally enough. She issued orders that it was to be air-brushed out. The picture duly appeared, with the bull looking somewhat crestfallen.

The owner of the bull promptly sued and won substantial damages.

Last week, the *Daily Mail* ran a lyrical story on the Queen's horses; "Exclusive," it said, "Brian Vine reports from inside the Sandringham Stud." The Queen has, it went on, "invested a fortune in shares in two top stallions..." There was then a description of the behaviour of one of these animals, who stood on his hind legs, "like a bronze sculpture". The name of the horse is Bustino. He was referred to as "a blue blooded top sire".

To illustrate the energy and good breeding of Bustino the paper duly printed a picture of him on his hind legs, like a bronze sculpture. But it was obvious from this that Bustino could not sire anything. His equipment was conspicuous, as the saying goes, by its absence. Perhaps he is a technological horse with a more than usually retractable undercarriage. Perhaps something went wrong in the camera. Perhaps those at Sandringham will sue. As things stand, or rather, as they seem to have no prospect of doing, stud fees may be something of a gamble. □

THIS week's picture is the second of the two winners of the competition for "ballooning" photographs organised by *NS* at the BA meeting in Norwich. Robert Paynter from Huntingdon will be receiving copies free of charge for 12 months. Commiserations for those who were unsuccessful, but they might look out for another such competition in the near future. □

IDIOCY is one thing, idiocy that costs other people money is another. If I were a member of the Automobile Association I would have been in its offices long ago, purple faced, demanding to see the boss. For the AA, I learn belatedly, has spent its members' money on a survey of a thousand drivers to see what sign of the zodiac they were born under. The results were then passed over to the president of the Astrological Association (was it some bright public relations scheme as the two organisations have the same initials?) to be "interpreted".

The rubbish that comes out of all this is typified by the statement, for example, that Capricornians favour black cars and Cancerians blue. People born under the sign of Leo want to drive such expensive cars as Porsches or BMWs. This utter claptrap is not the worst. Your sign is also alleged to affect the way you drive. □

And that's where we'll put the mouse's exercise wheel

HERE we go again. There is to be another government inquiry into the official policy of killing badgers, the animals suspected of spreading tuberculosis in cattle. I thought it had all been ironed out, incontrovertibly settled by scientific investigation and assessment, I forget by whom, that badgers were the culprits and that worrying about their fate was sentimental. Unfortunate, of course, but these decisions have to be taken, it's a hard world and so on.

Now it has been found that tuberculosis in cattle has actually increased on some farms, in spite of the badger holocaust that has been going on for about 10 years. One of the fears of those who are not, perhaps, entirely convinced of the case against badgers is that some officially trapped ones are being stolen for the revolting so-called sport of badger-baiting. Statements from the Ministry of Agriculture's spokesman about this are ineffably lofty, of course, unhelpful and unconcerned. □

AMONG the absurdities and violence of the animal rights raids, demands and appeals there appears, now and then, some cause that deserves support. Here is one.

The British Union for the Abolition of Vivisection (BUAV) is campaigning against the dissection of animals in schools, a normal part of biology lessons. Apparently, there are no rules or procedures laid down for this practice. Methods are what schools or teachers think are appropriate. According to the BUAV, more and more students are opposed to dissection and refuse to do it, even in the course of examinations, though they lose marks if they do.

As usual, the case against dissection in schools, like other worthy ones, is overstated. I doubt whether the observation by the union that the practice confuses people about right and wrong and that therefore it is hardly surprising that "society has so many problems and there is so much violence" is more than hyperbole. Nevertheless, I agree with the statement that dissection has no part to play in a civilised education system. □

SAP flows upwards through the stems of a plant by a suction mechanism. The sap is always under tension. In this, observes Daedalus, it resembles the liquid in a nuclear bubble-chamber. A subatomic particle traversing such a liquid leaves a trail of bubbles which expand into the tension. Sap-tensions, though, are vastly greater than those used in bubble-chambers: in tall plants they may reach many atmospheres. So, says Daedalus, plants should be very sensitive radiation-detectors.

At first he dreamt of tracking down solar neutrinos by means of vast underground giant-sequoia plantations, but he is now inventing a novel "nuclear agriculture". A radiation beam traversing a tree, say, will create bubbles in the sap-ducts at that point. These will break the flow of sap to the regions above. Total sap-blockage would kill the upper parts in a sort of "radiation ringbarking"; but milder irradiation should merely block a few channels and restrict the sap-flow for a while.

Daedalus sees this as a powerful new method of plant-shaping. If fruit trees, for example, were irradiated halfway up, the sap thus blocked would promote growth in the lower parts, spreading the trees out and making their fruit more accessible.

Ornamental shrubs could similarly be "sculpted", and stems could be bent or straightened by differential blocking of the ducts on one side. A whole plant could be slowed in its development by repeated weak irradiation at stem level. Selective slowing of specific plants in a crop of lettuces or broccoli, say, could "stagger" them into yielding usefully over several months, instead of all coming in a rush. Similar slowing of individual branches in a pear tree could conveniently stagger the crop of pears.

But really high-powered "nuclear landscaping", with hedges trimmed laser-straight by hundred-metre radiation beams, and lawns mowed or crops harvested by sheet-beams scything over acres at a time, might raise eyebrows in ecological circles. □

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newscientist MOLECULE DISCUSSIONS 1984

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Nigel Henbest
3.0 pm**

**NOV
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Dr Graham White
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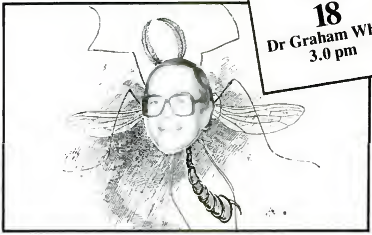

ET – Please phone Earth!

artians, Daleks, ET, aliens . . . the media persuade us that the niverse is teeming with life. But what is the evidence? Heather ouper and Nigel Henbest present the arguments for and against "life f Earth". From the frozen sands of Mars to the crucibles of starbirth, ientists are probing for clues to one of the greatest unanswered estions in science. Are we listening to broadcasts from other civilisa- ns? Can they detect us from our spaceprobes and the messages we beam out from our radio telescopes?

eather Couper is president of the British Astronomical Association, broadcaster and writer, and a former lecturer at the Greenwich anetarium. Nigel Henbest is astronomy consultant to *New ientist*, author of numerous astronomy books and a public relations nsultant to the Royal Greenwich Observatory, at Herstmonceux.

The most dangerous insects

Graham White discusses why mosquitoes and other blood-sucking insects are so dangerous in warm and exotic parts of the world. He considers what can be done to protect people who live in such parts, or visit them. He raises controversial arguments about the use of insecticides that may cause environmental pollution for the benefit of public health. These beautiful insects can transmit parasites causing a host of diseases. At least 600 million people are exposed to malaria and almost everyone on Earth has suffered mosquito bites at some time.

Dr Graham White used to be on the scientific staff of the British Museum of Natural History. He is now at the London School of Hygiene and Tropical Medicine. He often serves as a public health consultant to foreign governments on behalf of the World Health Organisation and other international agencies.

**OV
25
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.0 pm**

Energy and all that

Energy is the convertible currency of technology, explains Ian Fells. The chemical energy locked away in coal or oil was originally solar energy. When we burn coal or oil that chemical energy is converted into heat that we can use to raise steam to spin a turbo alternator and to generate electricity. In its turn, electricity can be converted to light or radio waves, or into destructive laser weapons. No wonder politicians seek to control sources of energy and economists concern themselves with its price and availability. Our high-technology civilisation would be unthinkable without electricity, yet half the world's population do not have a switch to switch it on.

Professor Ian Fells has worked at Sheffield University and is now professor of energy conversion at Newcastle University, where he is working on problems of unconventional electricity generation and storage. He has been a judge in "The Great Egg Race" since it started.

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